Vol. 144 SATURDAY, JULY 1, 1939 No. 3635

SCIENCE, INDUSTRY AND SOCIETY

THE meeting of the Division for the Social and International Relations of Science of the British Association which was held last week in Manchester provided a particularly apt illustration of the twofold functions of the new Division. The formation of the Division is the outcome of the new recognition on the part of scientific men themselves of their responsibility for the social consequences of their discoveries, to which Dr. J. S. B. Stopford, the vice-chancellor of the University of Manchester, referred in his address of welcome. While, however, the formation of the new Division has been widely welcomed outside the ranks of scientific workers themselves, as indicated, for example, in the remarks of Mr. C. Woodock, head of the economic and research department of the Trades Union Congress in the discussion, the meeting made it clear that educational work in this field must for some time to come be an important activity of the Division.

For this situation there are several reasons. In the first place, as Sir Richard Gregory pointed out in his introductory address as chairman of the Division, the prelude to effective action is clear thinking about the social implications of scientific work, of the uses that are being and could be made of science, of the abuse of scientific knowledge, and of the fuller use which could be made of it for promoting general social welfare.

Such educational activity is also of importance in securing the widespread support which is equally essential if scientific investigation is to be carried out in this field on any adequate scale. At the present time, as Sir Richard Gregory pointed out, the resources available for research on the effects on the community of scientific knowledge acquired or used are very meagre. Large funds already exist for industrial research, though the net annual expenditure of £600,000 of the Department of Scientific and Industrial Research—the most potent agent in Great Britain in promoting the application of science and scientific knowledge to industry—compares unfavourably with the national effort in other contries and might be trebled with advantage. No fellowships exist for inquiry into the effect of scientific and industrial change in the community, and a strong case could be made out for the organization and supply on a similar scale of facilities for research into the changes in the character and conditions of labour, the distribution of industries and population and the many other social problems involved in practical applications of scientific discovery.

It would indeed be difficult to choose two examples better calculated to illustrate the importance of the application of scientific method and research than the two industries—the cotton industry and the plastics industry—selected as the subject of the Manchester meeting. As

Dr. F. C. Toy pointed out, in the old-established cotton industry a period of great mechanical and chemical advance, up to the middle of the nineteenth century, in which the demands of the industry stimulated both scientific and mechanical discovery, was succeeded by one of comparative neglect and stagnation in spite of rapidly expanding trade. The scientific drive passed to the dyers or chemical industries, and scientific revival in the cotton industry only came about twenty-five years ago. Until 1910, there was scarcely a physicist in the industry, and this neglect of science by the industry well explains both the difficulties which from time to time the British Cotton Industry Research Association has experienced in securing support and the failure of the industry to utilize the results of scientific knowledge available for it.

Unquestionably this neglect of science has been a factor in the difficulties which the industry has experienced in meeting the competition of the new synthetic fibres. The development of fabrics which resist creasing or shrinking as well as stains, or which repel water, is largely due to fuller knowledge of molecular structure, and the development of crease-resistant cotton fabrics as a result of sixteen years research described by Sir Kenneth Lee is an example of the way in which scientific research can enable an industry to adapt itself to meet the demands of new conditions.

The value of a central research organization, however, as Dr. Toy pointed out, does not lie in the supply of new knowledge alone. It lies equally in the stimulus which it supplies to scientific and technical thought in the industry as a whole, while it should not be forgotten that industrial research often makes as important contributions to the advance of science itself as science does to that of industry. Indeed, this has been notably true in the development of the plastics industry, where scientific and technical advance have frequently been hand in hand. A remarkable example of this may be seen in the development of the new fibre 'Nylon' to replace natural silk.

If the feature of the plastics industry is its direct dependence on scientific research, few industries illustrate more conspicuously the reaction of applied science on the community. Frequently the development of plastics has been linked up with the advance of other industries, but apart from this, plastics are not merely meeting new needs by making possible the cinema, the roll-film, the gramophone record and the electrical industry as we know it, but they are also displacing other materials for constructional purposes, and as Dr. V. E. Varsley and Mr. E. C. Couzens pointed out, offer a new media for the expression of handicraft, possessing possibilities not found in wood and metal. Moreover, we are only on the threshold of the real plastics age, in which materials will be built up by chemical synthesis to meet the great majority of specific requirements.

The technical significance of such developments and the possibilities and advantages inherent in them should not be allowed to blind us to the profound influence which they may have on social life as well as on individual industries. More and more, however, it is realized that industrial efficiency can no longer be computed in mechanical terms; it must take full account of the human factor, and it must also be considered in relation to the welfare or efficiency of society as a whole. We need, as Prof. H. Levy urged in his Pedler Memorial Lecture (which also formed a part of the Manchester meeting), a system of social accountancy, which would provide the information necessary for informed judgment on social proposals.

In directing attention to this need for a survey of the efficiency of our social machinery and the changes it creates in the community, Prof. Levy touched on the second function of the new Division. It is not concerned solely with the education of scientific and public opinion in the social consequences of scientific discovery, at least to the point of lucid thought about definite and specific problems and the provision of means for the investigation. It is equally concerned with the elaboration of the technique for the investigation of social change.

In his lecture, Prof. Levy made a number of suggestions in regard to the measurement of social change which deserve the attention of the Division. A study of the social relations of science implies an examination of the way in which scientific and technical applications are reflected in physiological and cultural development in the community. We require accordingly a complete survey of the appropriate indexes in all these fields. We require measures of the technical level in commodity production contrasted with what might conceivably be attained at any moment; the relative degree of research activity in various branches of science; indexes for physical fitness for various social classes and their resistance to certain diseases; housing standards and educational facilities

compared with what might be attained with planning. Such indexes need not be more difficult to provide than the cost of living index.

The Manchester meeting of the new Division succeeded at least in providing impressive illustrations of the opportunities for the application of scientific method in the solution of problems of social change due to industrial development, no less than in industry itself. It may indeed be hoped that the meeting will encourage many more scientific workers to seek to bring to the solution of such problems the same attitude of mind and principles which they use in their research, and stimulate both the formulation of specific projects for investigation and the elaboration of the requisite technique and principles of investigation.

SCIENCE IN A CHANGING WORLD

Modern Science

A Study of Physical Science in the World To-day. By Prof. Hyman Levy. Pp. x+736. (London: Hamish Hamilton, Ltd., 1939.) 21*s*. net.

THE twentieth century has been an era of violence and change. In our acute awareness of this, we may fail to notice that in the midst of danger, insecurity and the destruction of human values and lives, a new order is insensibly being formed. Scientific men and practical men, starting from widely different viewpoints, are coming to think of things in the same way—one very different from that which satisfied us not so many years ago. Because of this very diversity of origin, it is difficult to grasp consciously what is happening, and yet that conscious grasp is what we feel we need most. Intellectual insecurity is only the counterpart of the present political insecurity of the world. That security can only be won by wide views and hard thinking. Prof. Levy's book is a notable contribution to the series of attempts to reformulate our knowledge in relation to the great internal and external changes it has undergone in the last few years. He has already written much upon this subject, but there is no doubt that "Modern Science" represents much more matured thought than any of his previous writings. Both those who are acquainted with Marxist views in science and those who are not will find it well worth their while to read carefully through its seven hundred pages.

The purpose of "Modern Science" is to bring into the scope of our thinking certain general considerations that have so far been relatively foreign to the tradition of scientific thought, and to show how these considerations are necessitated both by the internal developments of science and the discovery of new relations and contradictions in it, and by the increasingly acute impact of social events on the carrying out of scientific work. The book is addressed not only, and indeed not principally, to men of science, but also to intelligent persons in general. Because the language of science is not the common language, much explanation both of elementary and advanced scientific ideas is necessary, but the book is not so much an exposition of science as a criticism of the limitations of scientific thought and an indication of the lines along which it can be generalized and extended.

The four principal ideas which the author introduces with a wealth of examples are: the general interrelation of the processes of the universe and the consequent artificiality of scientific study in isolation; the prevalence of opposites both in the world of Nature and in our mathematical and physical ways of understanding it; the existence of critical changes of quality brought about by continuous quantitative processes; and the close and permanent interaction between the practical basis of social life and its intellectual interpretation in science. These are all ideas which until recently would have appeared strange and ridiculous to many scientific workers, and still seem so to many. The value of Prof. Levy's analysis is that he shows us that recent developments have made most of them an integral part of scientific thought. The quantum theory in particular brings out very clearly the significance of characteristic values of a physical variable and the presence of instability and discontinuous change. The theory of relativity, on the other hand, while appearing in one aspect as a culmination of the abstract and mechanical world view of Newton, is also one of the first recognitions of the need for comprehensiveness in the formulation of scientific law. From the new viewpoint, much of the science of the past is seen to be an answering of detail-problems, artificially isolated both in their antecedents and from the world around them. The new view does not alter science, but it does help to extend it, and in doing so to make it intrinsically more intelligible.

"Modern Science" is divided into seven parts. The first introduces science as a developing means of using and controlling energy. It shows how from the technical point of view we can have energy in abundance, but that we are still unable for political and economic reasons to make full social use of it. The final chapter, on the inversion of science, is particularly interesting. The second part contains

an outline of the main arguments of the book in a most general and practical way. The third part, on the universe of symbols, takes us into mathematics and exhibits the history of mathematics as a continuous struggle to achieve comprehensiveness and freedom. The fourth contains a most penetrating study of Newton's laws and of their generalization in the eighteenth and nineteenth centuries, illustrated by a chapter on aerodynamics, which brings out the relations between theory and experiment. The inadequacy of the Newtonian view is led up to by a fifth part dealing with projective and non-Euclidean geometry. This leads to the sixth and most interesting section of the book, which discusses the actual content of the universe from cosmology to atomic structure, and incidentally the relativity and quantum theories. The seventh part gives a concrete example of applied physical science—its use in the development of illumination.

Finally, we have an epilogue which sums up in nineteen theses the difference between the older views of science and those associated with dialectical materialism. It is impossible to quote more than a few of them, but the following may stand as typical.

DIALECTICAL METHOD	MECHANISTIC METHOD
1. The history of science and the growth of its ideas are intimately bound up with the history of social needs. Whether science will advance rapidly, or be retarded, will depend on how far society is consciously organized to this end.	1. Science is a thing in itself and its use by society is purely extraneous. Science has its own history, that of the erection of a system of logically connected ideas.
2. Scientific truth emerges through the interplay of theory and practice. Truths are not only discovered but made and transformed into greater truths. They are changed in the process of discovery and of verification.	2. Truth is discovered. It lies in the background as an absolute.
4. In science man learns to think logically by the force of experimental practice. His logical perceptions have therefore a history of growth and they reflect the natural processes to which he has been mentally compelled to adapt himself.	4. Man thinks logically in an absolute way. Such processes are unchanging and they analyse events in the universe, forcing them into a previously determined logical pattern.
8. The laws of Nature describe statistical regularities and are changing.	8. The laws of Nature are absolute and unchanging.
11. Process change implies continual qualitative change by the resolution of internal 'contradictions' into a more embracing synthesis. This implies a changing cause-effect relationship in which in each pair elements and groups play a dual role with respect to each other.	11. Cause and effect follow each other in isolation and the laws of Nature are always of the simple cause-effect type.
18. Since science is a form of action in social life and since decisions regarding social action have to be made, there must be a specific type of scientific approach at each level of human activity, from controlled laboratory science to the making of social history.	18. Without complete knowledge no scientific decision can be arrived at. Complete knowledge is defined as that demanded by physical science. Social activity cannot be carried through, therefore, in a scientific manner.

The theses bring out very clearly how much better the ideas of relativity and the quantum theory fit in with the dialectical mode than they do with the mechanical. But as Prof. Levy points out later, the importance of the dialectical method lies even more in the relations of science to society than in science itself:

"The scientific repercussions of a lack of the fullest appreciation of dialectical change in scientific work itself are slight. On the other hand, the social repercussions of a lack of appreciation of the dialectical changes produced by and on science in its interaction with society may be almost catastrophic. That this lack of appreciation exists is evident from the contradiction that persists in the minds of scientific men, and indeed all others who give thought to the matter, when they contrast the potentialities of science for abundance in social life with its adaptation as a means of ensuring scarcity." (pp. 708–709.)

This is a book for all scientific workers to read. It will provoke thought and discussion. Its length, which the need for elementary presentation makes necessary, is compensated for by the forcefulness and clarity of Prof. Levy's style, and by the excellence of the many illustrations.

J. D. BERNAL.

INSTINCTS OF THE HERD

The Social Life of Animals
By Prof. W. C. Allee. Pp. xiv+265+5 plates. (London and Toronto: William Heinemann, Ltd., n.d.) 12*s.* 6*d.* net.

WHEN Huxley wrote that among animals and among primitive men "Life was a continual free fight, and beyond the limited and temporary relations of the family, the Hobbesian war of each against all was the normal state of existence," he was, not for the first time, overstating the case. The idea that co-operation is as 'natural' and as fundamental as competition is at least as old as Empedocles. Darwin used the term 'struggle for existence' "in a large and metaphorical sense, including dependence of one being on another", and Herbert Spencer insisted that "from the dawn of life altruism has been no less essential than egoism". Patrick Geddes and Arthur Thomson used to impress upon their students the importance of sociality as a factor in animal evolution, and Kropotkin, uncritical though he was, did good service by pointing out the inadequacy of the gladiatorial theory of life. In recent years, the very active school of animal ecology directed by Prof. Allee in Chicago has given much attention to the problems of animal aggregations, seeking to discover the links that hold them together and the advantages, individual or racial, derived from them. In this volume, based on a course of lectures delivered at the Northwestern University, he gives a summary of the more important results of these researches and discusses their significance.

After a brief historical introduction, which might have been expanded with advantage, the author mentions those aggregations of individuals in which the connexion is structural, as in the groupings of fissiparous Protozoa that, presumably, gave rise to the Metazoa, and in the colonial Cœlenterates and the like. He then goes on to describe instances of swarms that are merely swept together by environmental action as plankton animals are by ocean currents, or that are attracted together to some favourable niche of the environment as Protozoa cluster round an air-bubble on the microscope slide or bats assemble in a suitable cave. We cannot tell when or where such accidental assemblages merge into those in which the individuals actively seek the company of their kind, or how mutual toleration leads towards co-operation and mutual aid.

The advantages—or, more precisely, the 'survival-value'—of these aggregations are sometimes obvious; mass defence against predators is visibly effective; but often they are more recondite. There seems to be a 'confusion effect', as when small birds flock together in presence of a hawk; the enemy's attention is distracted, and he is less likely to be successful than when he can concentrate his attention on a solitary victim. It may perhaps not be true that "the wolf cares not how many the sheep may be" and it is certain that a goldfish will eat more water-fleas if it is given a few at a time than if it is presented with the whole bewildering mass at once. Sometimes the advantage is plainly physical, as when hibernating small mammals huddle together for warmth; sometimes it is more subtly chemical, as when it is demonstrated that goldfish thrive better in pond water that has been conditioned by the previous presence of other goldfish. The ill-effects of overcrowding are often lamentably plain, with animals as with men, but there is a growing body of evidence bearing on the less obvious evils of undercrowding in the most diverse organisms ranging from Protozoa up to elephants.

As we proceed up the scale of animal life these various assemblages tend to become organized into more or less definite societies. Even the hen-run has its 'peck-order', although the cock of the walk enjoys only a precarious sovereignty and a very little may turn him into the persecuted butt of his companions. Innumerable gradations lead up to the highly integrated communities of bees, ants and termites in which the various castes are structurally as well as functionally differentiated.

On all these, and many related subjects, Prof. Allee has much to say that is interesting and important, and much that will, we believe, be novel to zoologists who have not given special attention to this department of their science. He writes in a readable style and his explanations are generally, though not invariably, easy to follow. There are, however, one or two points that seem open to criticism.

Prof. Allee is an experimentalist rather than a field naturalist, and he appears somewhat to neglect or to undervalue the great mass of field observations that bear on his subject. It is perfectly true that, as he says, many of these observations "can only be recorded as more or less interesting anecdotes", but there are others, of which the details have been fully collected and scientifically analysed, that are at least as deserving of attention as the results obtained in the laboratory. It is noteworthy that, of the field

observations thought worthy of discussion, some, like those relating to the elephant herds of the Knysna Forest and the Addo Bush (p. 89), are presented without the particulars necessary for forming a judgment on their significance.

The great advantage of the experimental method lies in the possibility of obtaining precise quantitative results. It demands a correspondingly careful handling of the numerical data in the exposition of these results. It is disappointing to find, therefore, that the very first table in the book (p. 38) flatly contradicts the interpretation of it given in the text. A reference to the original paper from which it is quoted shows that a transposition of figures has occurred. The diagrams on pp. 44 and 46 are taken from a paper still unpublished and they cannot, therefore, be checked, but the figures they contain give percentages widely different from those that are said in the text to be extracted from them. On p. 74 a certain coefficient is said to be "obtained by multiplying the number of fish by their average length in millimetres. . . ." A non-mathematical zoologist would get the same result by taking the sum of their lengths. In a book written in the United States and printed in England one may suspect difficulties in the matter of proof revision; but meantime Prof. Allee cannot complain if readers must suspend judgment on some of his conclusions.

One of the most telling chapters in the book is that entitled "Some Human Implications". There has been no more deplorable example of the crude application of biological principles to the complexity of human affairs than the attempt to justify international war in terms of the struggle for existence. Prof. Allee exposes very effectively the futility of this argument. If, on the other hand, co-operation, at first physiological, then instinctive, and latest of all, conscious, has been a factor in animal evolution no less important than competition, then biology does offer some hope to those who look forward to a better world order. In the meantime, alas, we, on this side of the Atlantic, must get on with our A.R.P.

W. T. CALMAN.

CRYSTAL CHEMISTRY

(1) An Introduction to Crystal Chemistry
By Dr. R. C. Evans. Pp. xi+388. (Cambridge: At the University Press, 1939.) 18*s*. net.

(2) Crystal Chemistry
By Dr. Charles W. Stillwell. (International Chemical Series). Pp. x+431+1 plate. (New York and London: McGraw-Hill Book Co. Inc., 1938.) 25*s*.

THE appearance of these two books is symptomatic of a new development in natural science, the birth of a comprehensive theory of the solid state. Both are the work of writers at least partly concerned with teaching, but whereas the first bears the firm impress of the university, the second is slightly technological, and reviews several interesting applications.

(1) Dr. Evans has assuredly written a volume which should never be far away from the mind and elbow of the serious student of the subject. A beginning is made by discussing in detail the forces which bind together the 'bricks' of which the crystal edifice is composed, after which the structures resulting from their interplay are examined systematically. Naturally, this latter portion of the book is much the larger of the two, since no important configuration is omitted. In addition, a place is found for a brief survey of liquid crystals, and for liquids themselves, and glasses. The author remarks that his intention has been to avoid overloading his pages with mere detail of crystal types: the effect is to maintain the reader's interest unabated.

The essence of Dr. Evans's thesis appears to the reviewer to be contained in the concluding discussion of Part 1; and indeed it could not have been better said. It is that the molecule, while all very well in the gaseous state, is not necessarily by any means such a helpful concept in crystals; in fact, it has been responsible for much over-emphasis upon the part played by the classical laws of chemistry. A somewhat similar restriction applies to valency, especially in intermetallic systems.

(2) To the student occupied in an orthodox course of chemical training, Dr. Stillwell's book will come as a welcome shaft of light. It has always been exceedingly difficult to introduce the properties (and indeed the very existence) of solids into such a curriculum without much artificiality. Crystal chemistry, treated as this volume treats it, will do much to help.

Perhaps of necessity the balance appears a little uneven: certain aspects like the silicates and ternary compounds are dealt with at length, whereas the question of colour, for example, receives somewhat old-fashioned and perfunctory

notice, omitting entirely the ingenious and subtle suggestions of Saha (1930–31) and the work that followed them. The format, too, is not very attractive, with its cramped setting, which makes the otherwise valuable tables difficult to follow.

It is tempting to compare the outlooks displayed by these two books. The Cambridge view of crystal chemistry is something like this. Here are the 'things', and here is a copy of the rules according to which the game is to be played. It now rests with the players, and the degree of skill which they have achieved is of no mean order. The American approach is otherwise: chemistry as usually taught is not altogether satisfactory; let it therefore be impregnated with a new and active principle, but the way will be long and the wind cold.

A profound study of the solid state is a first-rate intellectual pursuit in either case. For Dr. Evans, however, it is—probably subconsciously—great fun: one doubts whether it is quite that for Dr. Stillwell.

F. IAN G. RAWLINS.

SOME EASTERN AUSTRALIAN WILD FLOWERS

Wild Flowers of Australia

By Thistle Y. Harris. Pp. xviii+198+65 plates. (Sydney and London: Angus and Robertson, Ltd., 1938.) 8*s.* 6*d.*

AT a moderate computation, the flora of Australia contains some eleven thousand species of vascular plants. These are found over an area about twenty-five times the size of Great Britain and Ireland, in an island continent which extends through more than 28° of latitude. It is no easy task to select for illustration a fair example of such a flora. In spite of its title, the present book can scarcely be said to have done so. About ninety per cent of the plants figured and described in it come from the coastal district of New South Wales or the adjacent highlands. It is true that many of these same species do extend into Queensland, and a smaller number south into Victoria, but the representation of the floras of Tasmania or South Australia is slight. The small number of Western Australian plants included gives no useful impression of the peculiar flora of that State.

The author says that her book is an attempt to meet the demand for a popular guide to Australian wild flowers. No claim to completeness is made, but it is unfortunate that no space was found for any eucalypt and that not a grass nor a sedge is mentioned. Some of the figured species are uncommon plants, whilst others, quite as beautiful and far more widespread, are omitted.

The book is divided into two parts. The first contains illustrations of 248 species, reproduced by three-colour process and grouped in sixty-five plates. Although the individual blocks are small (2¼ in. × 1½ in.), in many cases the pictures are successful in giving a true impression of the form and colour of the plant illustrated. In other cases the artist has made the limit of the block a sort of Procrustean bed and taken unwarrantable liberties with the length of flower stalks to make the plant fit the picture. The result is a travesty of the plant, as in the figures of Brunonia, Dipodium, or *Drosera binata*. Much of the colour work is good and the figures of many of the Proteaceæ, Myrtaceæ and Epacridaceæ do give a real impression of the plants depicted. The blue tones have reproduced least satisfactorily; the figures of Cheiranthera and Stenochilus are quite misleading. For technical reasons in printing, the blocks on a plate have been grouped according to predominant colour, not affinity of the plants. This has led to a haphazard association of plants which, in some cases, might have been avoided. Each plate is accompanied by a popular description of the plants, their distribution in the different States and their flowering season. By some irritating mischance, only once does this account face the plate to which it refers. There are some inaccuracies: one in this section should be corrected. *Dipodium punctatum* is not a parasite, but a holosaprophytic orchid.

The second part gives a systematic account of the families with keys and a brief technical description of the species figured. As there have been inevitably so many omissions of the genera and species, these keys would be very misleading to a stranger trying to run down a plant. A visitor to the 'bush' near Sydney is as likely to find a Leucopogon, Woollsia or Monotoca as an Epacris; but there is no warning in the key to the Epacridaceæ that such genera exist. In any future edition, the derivation of the generic and specific names given in this part requires careful revision. One error cannot be passed. The Smith commemorated in the species *Zieria Smithii* was not "an Australian biochemist". Sir E. J. Smith deserves better of Australian botany than to be so forgotten.

T. G. B. OSBORN.

NEW PROSPECTS IN ISOTOPE SEPARATION

By Prof. Hugh S. Taylor, F.R.S., Princeton University

THE identification of the heavy hydrogen isotope and its separation gave considerable impetus to the search for methods of bulk separation of the isotopes of other elements. Previous to this time, the experimental man of science had been content to demonstrate that displacements of normal isotope ratios could be secured by one or other method. Aston and Harkins had shown that these ratios could be changed by diffusion processes in the cases of neon and chlorine. Brönsted and Hevesy changed slightly the atomic weight of mercury by distillation methods. It was the separation of the hydrogen isotopes and the demonstration of their extraordinary utility in many problems of chemical, physical and biological interest that re-awakened the interest in more complete separations of other isotopic elements. The simultaneous advances in the study of the nucleus, by bombardment with swift-moving primary particles, enhanced the desire for individual isotopic species of the elements, at the same time that it provided an alternative tool for research in the form of artificially produced radioactive elements.

The successful separation of the hydrogen isotopes by electrolysis has not been extended to other elements. The separation factor is too low in the case of oxygen to make the method practicable, and the same is true for lithium. The use of a series of diffusion pump units, developed by Hertz, has permitted large changes in isotope concentrations to be secured, notably with hydrogen, neon and carbon. The separation was complete in the first two cases, and 50 per cent ^{13}C has been secured with methane as the diffusing gas. Minor concentrations of heavy nitrogen and oxygen have also been obtained. The principal objection to the method is the small amount of concentrated products which may thus be secured, since the pumps operate at not more than a few millimetres pressure. Capron and de Hemptinne were enabled to increase the speed of attainment and the yield of 50 per cent ^{13}C from methane by incorporating in the pump circuit, at the light end, a reservoir of methane in the form of gas adsorbed on silica gel at liquid air temperatures. For the concentration of oxygen, the most promising method developed hitherto has seemed to be the distillation column method as constructed by Pegram, Huffmann and Urey.

The most encouraging successor to the electrolytic separation of hydrogen proved to be the isotopic exchange reaction method developed by Urey and his colleagues. With this method, isotopic ^{15}N has been made available in large amounts of moderate concentrations and smaller amounts of highly concentrated heavy isotope. In this method, ammonia gas is exchanged countercurrent with ammonium ion in a column, the heavy nitrogen accumulating at the bottom. The success of this process makes 100 per cent ^{15}N available, at not too great cost, whenever required. The extension to heavy carbon is in progress, involving exchange between hydrogen cyanide gas and sodium cyanide liquors, by which exchange simultaneous separation of both carbon and nitrogen may be secured. The laboratory scale data seem as promising as those of nitrogen. Sulphur can be similarly treated with a greater separation factor than with carbon. Exchanges with zeolitic materials may be employed in the case of the ions of the alkali elements.

The mass spectrographic method can obviously be employed for the separation of charged ions, and this has been put to use in the preparation of the small amounts of the lithium isotopes necessary for nuclear and transmutation reactions. The development of high speed air-driven centrifuges, notably by Beams of the University of Virginia, has led to their use in isotope separation. Units are now in operation on liquids, with continuous feed and bleed. Marked displacements of the isotope ratio of chlorine in carbon tetrachloride have thus been secured. This method is most promising for not too large separations but in marked quantities. The separation depends only on the atomic weight difference and not on the mass ratio, and can thus be applied to liquids containing isotopes of high atomic weight as well as to the lighter isotopes. The method requires, however, expensive equipment and a slowly acquired technique.

From the point of view of general availability in the average laboratory, the newest method of isotope separation developed by Clusius and Dickel[1] is the most interesting, and of great promise for the general solution of the problem of separation of gaseous and liquid isotopic materials in quantity. Clusius combines the well-known thermal diffusion process, suggested by Chapman, with a thermal syphoning process by carrying out the separation in vertical tubes in the axis of which is a hot surface, the outside surface being kept cooled. The original form consisted of a heated wire placed concentrically in a cylindrical tube. In tubes of one metre

length with a temperature gradient from centre to outside of 300–600°, it was shown that bromine in helium and carbon dioxide in hydrogen could be practically completely separated, the heavier gas concentrating at the bottom of the vertical column. With a three-metre tube, a four-fold concentration of oxygen in air was secured and a three-fold concentration of the heavy neon isotope. In the same tube a displacement of the chlorine isotopes in hydrogen chloride from 76 : 24 to 60 : 40 was secured in one operation. More recently[2] Clusius and Dickel announced the production in a tube of total length 36 metres, of 8 c.c. daily of hydrochloric acid of which more than 99 per cent of the chlorine was of mass 37. Simultaneously, at the top of the column two litres of hydrochloric acid (Cl = 35·147) was produced, from one litre of which 25 c.c. of hydrochloric acid (Cl = 35·06) could be produced. Further purification of this should, owing to the packing fraction of the element, give a chlorine of atomic weight just less than 35.

The method has been tested by W. Groth[3] on the separation of xenon isotopes in comparison with a 12-stage Hertz diffusion pump system which gives a displacement of 0·5 units in the atomic weight in 12 hours at 2 mm. pressure. The same displacement can be secured at atmospheric pressure in a 2·5-metre tube, 12 mm. wall diameter, heated down the centre by a tungsten wire at 1,000°. With a 5-mm. tube and a wire temperature of 1,650°, a displacement of 1·6 atomic weight units was secured. In a metre tube with a glass core heated internally, Brewer and Bramley[4] showed that a 27 per cent enrichment of ammonia at the bottom of the column with 50 : 50 methane (16) – ammonia (17) mixtures could be secured in fifteen minutes under favourable pressure and temperature gradient conditions.

The separation of the chlorine isotopes, successfully achieved by Clusius and Dickel, represents one of the most favourable cases for the operation of the thermal diffusion process. For, as Chapman showed, the separation is dependent on the product, C_1C_2, of the two fractions C_1 and C_2 of the mixture, respectively 0·76 and 0·24 in the cases of ^{35}Cl and ^{37}Cl. The separation of the carbon isotopes is much less favourable since the ratio ^{12}C to ^{13}C is 0·99 : 0·01.

Experiments conducted by G. G. Joris in the Princeton laboratories show, however, that even this mixture is capable of efficient resolution. In a column 1·5 metre long, with wall distance between hot and cold glass surfaces of 7·5 mm., a mean temperature of 400° K. and a temperature gradient of 450°, a separation factor ^{12}C : ^{13}C (bottom) ÷ ^{12}C : ^{13}C (top) of 1·21 is secured in one hour. In three separate three-metre columns with varying dimensions of hot and cold surfaces and wall distances from 7·5 mm. to 10 mm., with the same temperature conditions, the separation factor rose to 2, but in longer time intervals up to 5 hours. The most recent data secured on a 12-metre iron tube, 2 cm. internal diameter, heated axially by a chromel wire, No. 16 gauge, gave a separation factor of 3 in 48 hours with a heating current of 6 amperes, and a separation factor of 20 in 48 hours with a heating current of 9 amperes. This latter represents a concentration of the normal isotopic fraction of 1·1 per cent ^{13}C to 2·1 per cent at the bottom of the column and a depletion to ~0·1 per cent ^{13}C at the top of the column.

It is obvious that the maintenance of this separation factor will result in concentrations of upwards of 20 per cent ^{13}C at the bottom of the column when the normal ratio of 1·1 per cent ^{13}C is kept at the top of the column. Such experiments are in progress. In the 12-metre tube, 3·76 litres of gas at 20 cm. pressure at ordinary temperatures are employed, methane being the gas used for the separation. Experiments by Prof. T. Ri, in the smaller columns, with carbon dioxide – oxygen and nitrogen – ammonia have shown that the separation factor depends on composition variables, on the pressure (the factor shows, in agreement with a previous finding of Brewer and Bramley, a broad maximum in the region of 20–30 cm.) and most pronouncedly on the temperature gradient. This is obvious from the preceding data in the 12-metre column and also from data obtained with nitrogen – ammonia mixtures in the 1·5-metre column.

The theory of the thermal diffusion – thermal syphon process is complex. Two contributions are now available, one by Waldmann[5] and a paper by Furry, Jones and Onsager[6]. From Waldmann's paper the superiority of the process over straight thermal diffusion is measured by the ratio 0·67 h/d^* where h is the height of the column and d^* is of the order of magnitude of the distance between hot and cold surfaces. The convection therefore multiplies the thermal diffusion effect enormously in tall columns. The temperature gradient also plays a determining role in the same theory. That the process is also applicable to liquid separations is evident from data of Clusius and Dickel[7] with sodium chloride solutions, acetone – water mixtures, and light and heavy water. The same conclusion is reached from the data of H. Korsching and K. Wirtz[7] with *n*-hexane – carbon tetrachloride and benzene – chlorobenzene mixtures.

[1] *Naturwiss.*, **26**, 546 (1938).
[2] *Naturwiss.*, **27**, 148 (1939).
[3] *Naturwiss.*, **27**, 260 (1939).
[4] *Phys. Rev.*, **55**A, 590 (1939); *Amer. Chem. Soc. Abstracts*, Baltimore Meeting, April 1939.
[5] *Naturwiss.*, **27**, 230 (1939).
[6] *Phys. Rev.*, in the press.
[7] *Naturwiss.*, **27**, 110 (1939).

THE GAS INDUSTRY IN GREAT BRITAIN

WILLIAM MURDOCH died one hundred years ago and, at the annual meeting of the Institution of Gas Engineers on June 6 last, his position as founder of the gas industry received grateful commemoration in a Murdoch Centenary Lecture delivered by Dr. E. F. Armstrong. The lecture was only to a small extent biographical, although points of interest are recorded bringing out clearly the all-round quality of the man as a born engineer "of admirable inventive power and common sense genius", to quote the tribute of Nasmyth. It was made the occasion for the preparation of a reasoned history of the gas industry in Great Britain in the small compass of sixty-seven pages, brief but packed with information concerning the highways and some of the byways on which the industry has travelled in time.

Although Murdoch is accorded his rightful place, proper acknowledgment is made of other founders of the industry, such as Samuel Clegg, whose "mark on its history is second only to that of Murdoch" and who became engineer of the Chartered Gas Company in 1813 and had "practically single-handed to give a public service supply. Thus, when a few gas lamps were first installed on Westminster Bridge, the lamplighters refused to handle them so that he had to go round with his ladder and light them himself". Scepticism on the practicability and safety of public lighting with gas was very general and was shared even by men of the scientific calibre of Humphry Davy. Winsor also is not forgotten, a man of little technical knowledge but a fervent enthusiast, described as the "exploiter, propagandist and undaunted impresario of our Industry, to whom must be given the credit for the idea of widespread illumination from a single source".

The year 1839 was unusually eventful and, under the heading "A Century Ago", Dr. Armstrong sketches a background of contemporary happenings. In 1839 the first railway train left Euston on the first stage of the new London to Birmingham railway, the *British Queen* made the Atlantic crossing under steam alone, "Nicholas Nickleby" was published and people were reading Carlyle's "French Revolution", issued two years earlier, and the *Sunday Times* for January 13 reported that "On Thursday evening Hounslow was lighted up for the first time with gas supplied from the gasworks at Brentford. There are 18 lights." Both steam and gas, two great industrial users of coal, one for power and the other for lighting, had become more or less established by this time, and in an appendix Dr. Armstrong gives a list of ninety gas companies established by Act of Parliament up to 1839.

A patent was granted in 1819 to David Gordon for compressing gas and supplying it in copper cylinders under a pressure of 30 atmospheres, and such 'portable gas' was used at the Royal Institution until 1834, when it was replaced by coal-gas. "Historically", Dr. Armstrong points out, "the Portable Gas Company must always be associated with the discovery of benzene which Faraday separated in 1825 by distillation of the condensed oil gas liquor that collected in the vessels used by the Company."

The primary use of gas for more than a century was for lighting, and the story of the development of the apparatus in which it was burned has been well told by Dean Chandler. The invention of the incandescent mantle by Welsbach, first shown to the public in 1887, came at the right moment because "the electric bulb was introduced only a year or two earlier and started a new era of competition with gas-lighting". Dr. Armstrong quotes interesting figures for public lighting by gas in the area supplied by the South Metropolitan Gas Company. In 1899, with flat-flame burners, the candle-power per cubic foot of gas consumed per hour was 2·5; in 1902, with upright incandescent burners, 14·0; and in 1938, when 70·6 miles of lighting by high-pressure lamps was included, the figure had risen to 43·0.

As the gas industry in Great Britain developed and monopoly of supply was granted to each company in its own area, the absence of competition and the technical possibility of producing a larger volume of leaner gas through the use of fireclay retorts (instead of iron) at a higher temperature brought into prominence the necessity for a rigid control of gas quality. For this purpose the City of London Gas Act of 1868 appointed a body of three competent and impartial persons known as the 'gas referees' to prescribe apparatus and methods to be used in the testing of gas. This arrangement continued until a few months ago when, as Dr. Armstrong regretfully remarks, "The disappearance of the Gas Referees, as the result of the Gas Undertakings Act of 1934, which has transferred their duties to the Board of Trade, has meant the loss of a contact with leaders in the scientific world to which the Gas Industry has attached great value." This is none the less true although, since the passing of the Gas Regulation Act of 1920, calorific value has quite rightly taken the place of illuminating power as the criterion of quality throughout Great Britain.

It was recognized early in the history of the gas industry that the presence of sulphur compounds in gas was very objectionable and Clegg tried as early as 1805 the device of putting lime into the tank of the gas-holder for purification. Dr. Armstrong points out that eleven different processes were in operation in the gas works of the Metropolis in 1856–57. The complete removal of sulphuretted hydrogen by iron oxide, revivified by air, has become standard practice, but the residual sulphur compounds, amounting usually to some 20–30 grains per 100 c. ft. still provide an incentive to research, although oil-washing for benzole and the Carpenter-Evans catalytic process have both been applied successfully to lower this figure.

The usefulness of gas as a fuel for heating purposes and its virtues were "extolled by the indefatigable Winsor". Alfred King invented a gas-cooking-stove so early as 1830, and in 1872 the Salisbury Gas Company commenced hiring cookers to consumers. The earliest attempts were simply solid fuel ovens with gas burners inserted, and Dr. Armstrong traces the development to the cooker of to-day with enamelled finish, thermostatic control, safety-taps, quick-boiling burners and other useful adjuncts. By 1850 there were a number of gas fires in use, these consisting merely of lumps of pumice or other incombustible matter in a coal-grate with a gas-burner below. It was not until between 1904 and 1908 that the gas-fire radiant was introduced, and a new impetus was given to efficiency of design by the experimental study of the gas-fire by the newly formed Joint Research Committee of the Institution of Gas Engineers and the University of Leeds. Modern design is directed to high radiant efficiency combined with a distribution of heat making for the maximum of comfort. Ventilation too has been studied in detail. The rise in radiant efficiency is given by Dr. Armstrong as from 29 per cent on the gross calorific value in 1909 to 45 per cent in 1939 on the same basis.

It is not possible to make more than a mention of many other matters which are included in the lecture, some gratifying curiosity and others a deeper interest; for example, the possibilities of a greatly increased load for industrial heating offer an excellent example, and the whole range of secondary products, such as coke, tar and ammoniacal liquor. The modification of the retort from iron to fire-clay, horizontal to vertical, intermittent to continuous, and the whole subject of water-gas must be left, as well as an interesting page on co-partnership and a synopsis of gas legislation. There is, too, a suggestive final chapter entitled "The Present and Future of Gas", indicating possible lines of advance and insisting on the gas industry's taking a pride in attracting the best men into its ranks both as whole-time workers and as advisers. JOHN W. COBB.

CERCOSPORA LEAF SPOT DISEASE OF BANANAS

By DR. C. W. WARDLAW, IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD

THOUGH widely distributed in the Indo-Malayan and Australian regions and known to mycologists since 1902, the leaf spot disease of bananas caused by *Cercospora musæ* Zimm. (also known as Sigatoka disease) was not recorded in the western tropics until 1934[1]. It is not known precisely how or when this malady was introduced into the Caribbean region, or whether its spread took place from one or several foci of infection; but during the brief period of two to three years from its first recognition in Trinidad it had appeared with epidemic intensity in many of the islands and on the mainland of Central and South America, and by its destructive effects on plantations showed itself to be a disease of first-class economic importance.

Briefly, the disease manifests itself as a profuse spotting of leaves; later, the tissue around the spots begins to die rapidly and large, coalescing dead patches appear, so that in severe infections the leaf may be more or less completely destroyed (Figs. 1 and 2). Bunches on affected plants show slow or arrested growth and behave abnormally during development and subsequent ripening. Where the economic situation permits, the disease is being fought by dusting and spraying with various copper-containing fungicides.

SPREAD AND INTENSIFICATION

Information on the spread and intensification of a disease from an initial infection to the stage where it has assumed epidemic proportions is not always available to the investigator. In Trinidad, however, it has been possible to follow the progress of Cercospora leaf disease through its several phases. The disease was first observed in the Maqueripe district in north-west Trinidad in a small, new plantation of Giant Governor bananas, the planting material for which

Fig. 1.
SEVERE SPOTTING OF BANANA LEAVES BY *Cercospora musæ* Zimm.

(underground rhizomes, bulbs, etc.) had been obtained from scattered plants in the southern part of the island in January 1932. Leaf spotting became conspicuous towards the end of 1933, and plants of the Dwarf Cavendish variety in immediate proximity also became infected, though in a less severe form, some time later.

During frequent inspections at the beginning of 1934, Cercospora leaf spot was not observed anywhere in the Maqueripe district except in this one area, the Giant Governor plot being the centre of infection. A thorough stripping and burning of all diseased leaves was undertaken; but this did not halt the progress of the disease, and by the end of 1934 it became evident that adjacent Gros Michel blocks planted in 1932–33 had become infected. An island survey undertaken about this time showed that the disease was also becoming generally distributed, but whether only from Maqueripe or from several foci of infection is not known.

At this stage, the Gros Michel blocks at Maqueripe, though generally infected, showed little diminution in productiveness. The general mycological observation made during 1934–35 was that the older the stand of plants, the more intensive was the infection; but premature ripening of bunches on the plant, as previously recorded by Australian workers, was nowhere observed. During 1936 production was seriously affected: plants at all stages of development were severely spotted, many bunches showed slow or arrested development and an increasing number of commercial bunches was spoilt by premature ripening. During an inspection in January 1937, practically every bunch of export size showed this symptom. The intensification of infection to the point where premature ripening of bunches becomes general is the most serious economic aspect of this disease.

PHYSIOLOGICAL ASPECTS

On physiological grounds, several aspects of the disease require comment. It is known from detailed studies undertaken by Stahel[2] in Suriname that leaves can only be infected when quite young, that is, at the time of unrolling or soon after, the pathogen entering by way of the stomata. Penetration of the tissues takes place slowly, typical lesions requiring from three to four weeks for development. Although *C. musæ* may cause serious losses on a wide range of soil types, the severity of spotting and rapidity of leaf destruction appear to be associated with certain adverse growth conditions, unfavourable water relations (as in water-logged clay soils, light soils subject to rapid drying out, etc.) being important[3]. The debility and premature ageing of leaf tissues, known in some instances to be determined by unfavourable water relations, may be envisaged as standing in somewhat the same relation to Cercospora leaf disease as does the premature senescence of fruits to the early development of latent infections. It is relevant to note that in resistant varieties only the oldest leaves normally become spotted. But where such varieties are being grown under conditions which make for extreme physiological drought, some of the younger leaves may also show the development of typical Cercospora lesions.

Fig. 2.
SEVERE SPOTTING OF LEAVES BY *C. musæ* Zimm. FOLLOWED BY THE DESTRUCTION OF CONSIDERABLE AREAS OF LEAF TISSUE.

Severe leaf spotting is accompanied by the development of a buff to pale ochraceous salmon colour in the pulp. A less conspicuous but easily observable symptom is the presence of a characteristic pale bluish discoloration of some of the vascular strands of the true stem. These contain vessels in which various pathological symptoms, including the production of tyloses and the collapse of vessels, have been or are being induced as a result of the diseased condition of the leaves. In severely diseased plants, where the bunch is still quite small and immature, this symptom can also be observed. As the development of the bunch proceeds directly from the storage rhizome and indirectly from the leaves, it may be suggested that, as a result of severe leaf disease, the rhizome is itself to some extent in a physiologically unbalanced condition or affected by toxic fungal secretions. If support for this view can be obtained, it will have an important bearing on the elucidation of the progressive intensification of infections described above, and of other aspects of the disease.

Effect on Commercial Fruit

Severe attacks of Cercospora leaf disease are accompanied by a premature ripening of bunches while still attached to the plant. When the disease is less severe, apparently normal green bunches may be harvested, but during the 30–36 hours that elapse before the bunches are charged into the holds, individual fruits or a majority of the fruits of affected bunches may become soft and yellowish. In still less severe infections, affected bunches may escape detection at the wharfside, but may become soft and coloured during the period of refrigerated transport. Bunches which are only slightly affected may behave as approximately normal fruit.

In bulk storage trials, details of which are given elsewhere[4], it has been conclusively demonstrated that when bunches harvested at "¾-full" (English) grade from a plantation showing what might be described as an intermediate intensity of Cercospora leaf disease, are held at 53° F. for fifteen days with subsequent ripening at 68° F., evidence of abnormal storage behaviour can be observed. Affected fruit is characterized by pulp or a more or less well-marked buff colour, it tends to ripen prematurely, to develop 'chilling' symptoms during the period of refrigerated transport, and to ripen with undesirable rapidity on removal to a higher temperature. Flavour and aroma are also affected. So far nothing is known of the biochemical nature of the abnormalities present in affected fruit at harvesting, but after cold storage it may be expected to share some of the undesirable features of fruit which has been chilled. 'Cercospora bunches' ripened at tropical temperatures frequently show a profuse development of anthracnose spots (*Glœosporium musarum*) on attaining to the 'eating ripe' condition.

The effect of Cercospora leaf disease on fruit physiology is twofold: (i) ripening abnormalities are introduced; and (ii) bunches tend to remain of small size; hence, as fruit may actually be considerably more mature than is indicated by its appearance, further departures from the normal storage behaviour for that grade may be anticipated.

Specific and Varietal Susceptibility of Bananas

Since the first recognition of this disease, various commercial varieties, including the Gros Michel, Dwarf Cavendish, Congo and Giant Governor have proved highly susceptible under plantation conditions. When plants of the Imperial College Hybrid, I.C.2 (derived from *M. acuminata*, a wild seeded species as male parent, and the Gros Michel as female parent) were established in close proximity to severely affected Gros Michel plants, it was observed that spotting only occurred in a mild form on the oldest, senile leaves. This variety, in brief, apparently possesses considerable inherent resistance to infection or exploitation by *Cercospora musæ*—an observation which again directs attention to the importance of attempting to secure new commercial types of bananas by appropriate hybridization studies.

By way of amplifying knowledge of the relation between hereditary constitution and susceptibility to Cercospora leaf disease, a survey was made by Prof. E. E. Cheesman and the writer of the very considerable collection of types, species and hybrids available for study at the Imperial College of Tropical Agriculture[5]. Three definite conditions have been recognized: of the twenty-two types and two sub-types, thirteen are definitely susceptible, eight are highly resistant or immune, and three are *mildly* susceptible, spotting as a rule occurring only on the oldest leaf of fully grown plants, or plants bearing bunches. Among the species collection, a high degree of resistance is the rule: *M. acuminata* Colla (clone *A*), *M. balbisiana* Colla (clone Ceylon), *M. textilis* Nee, *M. ornata* Roxb., Pisang Lilan, undetermined species from Annam and Burma have consistently remained quite free from Cercospora spotting although growing in close proximity to severely infected stools of susceptible varieties. Among a third collection comprising sixteen different clones, referred to *M. balbisiana* (*M. sapientum* L. *senus* Roxb.) no spotting has occurred. In the collection of Imperial College hybrids, most of the plants, with some interesting exceptions, are quite free from leaf spotting. Among a large number of

other hybrids in which hereditary characters from parental wild species are prominent, a noticeable absence of leaf spotting is again the rule.

In both the species and hybrid collections it is to be noted that infections described as *mild* are all characteristically of one kind, spotting occurring only on the oldest leaf. Recent field observation on plots of I.C.2, located in different parts of the island, indicate that where Cercospora infections occur, they are invariably of the mild type.

The hybrids mentioned above have been raised in the course of a breeding programme directed primarily towards the control of Panama disease (*Fusarium oxysporum cubense*) and their resistance to an entirely different malady is as interesting as it is potentially important. It may also be pointed out that the eight varieties highly resistant to Cercospora are all likewise highly resistant to Panama disease. The numerous qualities required of a commercial banana remain the same whether it is to be bred resistant to a wilt or to a leaf spot. Evidence has accumulated to show that combining those qualities in a single plant is the real problem of banana breeding, rather than disease resistance alone. The conclusion has already been drawn that the greatest hope of obtaining a good export banana resistant to Panama disease lies in breeding from Gros Michel with appropriate wild species. It follows that the best hope of obtaining a good export banana resistant to Cercospora leaf spot lies in the same direction[5].

[1] Wardlaw, *Trop. Agric.*, **11**, 7, 173–175 (1934).
[2] Stahel, *Trop. Agric.*, **14**, 9, 257–264 (1937).
[3] Wardlaw, *Trop. Agric.*, **14**, 4, 117–118 (1937).
[4] Wardlaw, Leonard and Barnell, *Trop. Agric.*, **14**, 6 (1939).
[5] Cheesman and Wardlaw, *Trop. Agric.*, **14**, 12, 335–36 (1937).

OBITUARY

Dr. E. T. S. Appleyard

THE tragic death of Dr. E. T. S. Appleyard through injuries caused by a fall came as a great shock to his many friends. He was born in 1904, the son of Edgar Snowden and Elizabeth Appleyard of Huddersfield. He received his school education at Almondbury Grammar School and entered Cambridge as a scholar of King's College. Taking a first class in physics in the Natural Science Tripos, he spent several years on research in the Cavendish Laboratory. In 1929 he was appointed to a George Wills research associateship in the Wills Laboratory at Bristol, a post which he held until his death. During the tenure of this post he was awarded a Rockefeller fellowship for the session 1931–32 in the University of Chicago.

Appleyard's first research in the Cavendish Laboratory was on the polarization of the light emitted from atoms bombarded by a directed beam of electrons, and this was afterwards extended to the case of excitation by positive ions.

Following upon a few minor papers in spectroscopy in his earlier years at Bristol, Appleyard embarked upon a new field to which he made important contributions. With Lovell (*Proc. Roy. Soc.*, 1936, 1937) he investigated the nature of thin metallic films of the alkali metals evaporated on to a cooled surface *in vacuo*, by measuring their electrical conductivity under varying conditions. This work threw an entirely new light on the subject and cleared up many previous discrepancies in the literature. He followed this with similar work on mercury films, and with the co-operation of the Royal Society Mond Laboratory and the collaboration of Bristow, Misener and London, he extended the investigation to the superconducting state. A summary of his results on the variation of magnetic field penetration with temperature has already appeared in these columns (**143**, 433; 1939), and his last active work was to complete the paper describing the investigation in detail. Its consequences are of much significance and the results have already created considerable interest.

Appleyard was a very able physicist with an acute and critical mind. His wide knowledge, not confined to his own fields of work, made him an invaluable member of a research laboratory. In addition to research he took his share in the teaching and supervision of Part II honours students at Bristol, a number of whom have stated how much they appreciated the thought and time he gave to their interests. Indeed his willingness to be of assistance to everyone in the laboratory, academic and laboratory staff alike, and his desire to ensure that the fullest credit was given to all who helped him in his work, was one of his most lovable characteristics.

Appleyard experienced great pleasure, which his colleagues shared, on the success of his recent experiments on superconductivity, and a fruitful field of research for some years on similar lines seemed to be open to him. It must now be left to others to carry it on. He will be sadly missed. A. M. TYNDALL.

WE regret to announce the following deaths:

Dame Maria Ogilvie Gordon, known for her work on the geology of South Tyrol, on June 24.

Sir Frederick Hobday, C.M.G., honorary veterinary surgeon to the King, formerly principal of the Royal Veterinary College, on June 24, aged sixty-nine years.

Dr. Witmer Stone, emeritus director of the Academy of Natural Sciences of Philadelphia, on May 23, aged seventy-two years.

Dr. Yojiro Wakiya, formerly director of the Fisheries Institute, Fusan, Chosen, on April 21, aged sixty-seven years.

NEWS AND VIEWS

The Royal Visit to America

THEIR MAJESTIES were greeted on their return to England on June 22 and again on their drive to, and from, the Guildhall in the City of London on the following day with enthusiasm which needed no pageantry, no ceremonial, to quicken its sense of the significance of the events of the brief period which have elapsed since the King and Queen sailed for Canada on May 6. King George and his Consort were being hailed as conquerors—conquerors of a continent—no less certainly than were those of their predecessors, who in days gone by had passed through Temple Bar to celebrate a victory in the capital city. In this enthusiastic, but intimate, greeting of King and Queen there was a deep and strong undercurrent of loyal gratitude to them that in their journey from one end to the other of the vast Dominion of Canada, and no less in their visit to its great neighbour, the United States of America, their Majesties had so borne themselves that personal devotion to those wearing the Crown and a spirit of kindly hospitality to honoured guests had been transmuted to a deeper consciousness of the common devotion of all, President and citizen, Sovereign and subject alike, to the ideals of liberty and justice which transcend birth, creed and the barriers of national division in a supreme loyalty to the cause of humanity. In all the ceremonies and incidents of the Royal tour which, as His Majesty said at the Guildhall with a homely but happy touch of common interests, have been made "familiar . . . through the daily press, the news reels, and the Broadcasting Corporations", none was so deeply charged with emotion, none so moving to those gifted with historical imagination, as the simple scene in which King George laid a wreath upon the tomb of George Washington. This act of homage epitomizes as a symbol a memorable episode in the history of the British Commonwealth of Nations no less surely than His Majesty's impression of his experience, summed up in the memorable words "the strength of human feeling is still the most potent of all the forces affecting world affairs".

Pilgrim Trust Lecture

THE Pilgrim Trust Lectures, administered jointly by the Royal Society and the U.S. National Academy of Sciences, were inaugurated last December by a notable lecture delivered by Dr. Irving Langmuir in the theatre of the Royal Institution, London. The selection of the lecturer for the second of the series was in the hands of the Royal Society, which decided, most appropriately, to send its president, Sir William Bragg, as the ambassador of science in Great Britain to the United States. Sir William visited the United States during the spring, and on April 24, in the course of the annual meeting at Washington of the National Academy of Sciences, delivered the second Pilgrim Trust Lecture, which appears on p. 21 of this issue of NATURE. The effect of science upon social conditions formed the theme of Sir William's address, which he illustrated by dipping into the history of the Royal Society. Starting as a body of 'virtuosi' who met for discussion and experiment about the middle of the seventeenth century, the Royal Society early became concerned in problems of interest to a wider circle and to the State. Inquiries submitted to correspondents, their reports, and papers read before the Society, illustrate the effects of science upon society and conversely, of the circumstances of the times upon scientific investigations. Sir William leads up to an eloquent plea for the earnest consideration of current affairs in the spirit of science, which links up with the efforts of the Division for Social and International Relations of Science of the British Association; the Manchester meeting of the latter referred to on p. 1 of this issue deals specifically with some social aspects of scientific research, while Sir William points the moral on the wider issue.

Mr. M. G. Evans

THE chair of physical chemistry in the University of Leeds which fell vacant by the death of Prof. H. M. Dawson in February last, has been filled as from October 1 by the appointment of Mr. M. G. Evans, lecturer in chemistry in the University of Manchester. Born on December 2, 1904, he was educated at Leigh Grammar School and passed through the University of Manchester, where he was a pupil of Prof. A. Lapworth. While Prof. Hugh S. Taylor of Princeton was staying as a visitor for one term at the University of Manchester in 1931, Mr. Evans joined him in research on adsorption, and he renewed this connexion later by working for one year in the Frick Chemical Laboratory in Princeton, where he was closely associated with Prof. Henry Eyring. Since his return to Manchester in 1934, Mr. Evans has steadily developed his theoretical investigations on the mechanism of chemical reactions. During this time he has richly contributed to the fund of ideas which, it is the hope of the younger school of physical chemistry, promises to form a pattern for the understanding of at least the simpler types of reactions. Though Mr. Evans's principal contributions to science are in the theoretical field, he also took active interest in the experimental work carried on in Manchester. His appointment to one of the three chairs in the Department of Chemistry in Leeds is a significant recognition of the part which the new theories originating from quantum mechanics have to play in the life of chemistry to-day.

Dr. J. B. Speakman

THE appointment of Dr. J. B. Speakman to the chair of textile industries of the University of Leeds will afford pleasure to the many admirers of his work on the structure and properties of the wool fibre. Dr. Speakman is a graduate and D.Sc. of the University

of Manchester, where, except for a period of war service, he spent the years 1915–1920. His next three years were passed at Eton with Prof. R. Whytlaw-Gray, carrying out research on aerosols for the Chemical Warfare Committee. Since 1925 he has been in charge of the Textile Chemistry Laboratory of the University of Leeds, where he was appointed lecturer in 1925 and reader in 1937. Dr. Speakman has been awarded the Warner Memorial Medal of the Textile Institute, and three times he has been the recipient of the Research Medal of the Worshipful Company of Dyers. He has also served for a dozen years on the council of the Textile Institute, and on the Publications Committees of the Textile Institute and the Society of Dyers and Colourists. Under his direction, the Leeds Textile Chemistry Laboratory has attained a high and well-deserved reputation, and his new appointment will undoubtedly lead to still wider successes in his chosen field.

Dr. R. G. S. Hudson

DR. R. G. S. HUDSON has been appointed to succeed Prof. A. Gilligan as professor of geology in the University of Leeds. Dr. Hudson studied geology at University College, London, under Prof. E. J. Garwood. He later joined the staff of the Geological Department at University College and commenced research on the fauna of the Yoredale Series. He continued his interest in Carboniferous stratigraphy after his appointment in 1922 to the geological staff of the University of Leeds. The greater part of his work has dealt with the Dinantian and Namurian of Yorkshire especially with the relation between the various facies and faunal assemblages. He early demonstrated the unconformable junction between the Lower and Upper Carboniferous of Yorkshire; later, with Dr. G. H. Mitchell he described the geology of the Skipton anticline, and with the aid of various grants put down a boring in that area to the base of the Carboniferous. He has devoted attention to the Variscan orogeny and its control of sedimentation. His interest in the fauna of the Carboniferous has resulted in the description of new genera and species of corals such as Rylstonia, Rhopalolasma, and various species of Orionastræa. In 1931, Dr. Hudson was awarded the Wollaston Fund of the Geological Society and has served on the Council of that society. He has also been secretary of various committees of Section C, British Association, and is now joint secretary of that section. Dr. Hudson has taken considerable part in the organization of the geological societies in Yorkshire, and for some years has been editor of the *Proceedings of the Yorkshire Geological Society* and the *Transactions of the Leeds Geological Society*.

Imperial Cancer Research Fund: New Laboratories

THE new laboratories of the Imperial Cancer Research Fund were opened on June 27 (see also p. 41). Sir Humphry Rolleston, chairman of the Executive Committee, read a message of regret from Lord Halifax, president of the Fund, who at the last moment had found himself unable to attend. Lord Halifax said that all would appreciate that at the present time he is even more than usually subject to sudden and unavoidable calls on his time and that although he ought not, perhaps, to have agreed to open the new laboratories he had been particularly anxious to do so. Lord Halifax sent the notes which he had prepared for his speech, in which he reviewed the history of the foundation of the Fund and its progress. He referred to the many famous men, including Lord Lister, A. J. Balfour and Joseph Chamberlain, who helped the Fund and mentioned the policy of collaboration with all organizations at home and abroad which has been followed throughout the thirty-seven years of the Fund's existence. An address on "Scientific Aspects of Cancer Research" was delivered by Sir Frederick Gowland Hopkins, whose theme was the importance of laboratory effort in cancer research. He expressed his own faith that each increase in accommodation provided for skilled laboratory effort has never failed to be justified by its results. Sir Frederick described the distinguished past of the Fund and stated his confidence in a future of continued and eminent success. A vote of thanks to Sir Frederick was proposed by Sir Robert Hutchison, president of the Royal College of Physicians and seconded by Mr. Hugh Lett, president of the Royal College of Surgeons.

THE laboratories, designed by Messrs. Lanchester and Lodge, occupy an open position on the Ridgeway at Mill Hill. The three-storied main building is built in T-form with a central staircase; the corridors, as a result, are short and well-lighted. A goods lift serves one wing which is devoted mainly to animal rooms, stores and service rooms. The library, offices, one large laboratory, a room for X-ray equipment, centrifuge room, workshops and stores are on the ground floor. The first floor comprises a large chemical laboratory with a smaller laboratory adjoining, five other private laboratories, photographic room, sterilizing room and animal rooms. The Director's office and laboratory are on the second floor, where there are three other laboratories, operating room, histological room and animal rooms. There is a cold room in the basement. The laboratories vary in size; some are suitable for one worker using simple equipment; others can accommodate two or three workers or bulky apparatus. Most of the rooms have one high and one low bench each with a sink supplied with mains pressure water and hot water; gas and 5 and 10 amp. electric points are provided. The natural lighting, by large windows, is notably good. Artificial light is supplied by central pendants and supplemented, wherever required, by Anglepoise table lamps. Elaboration of structure and equipment has been avoided in favour of adaptability to varied needs. A detached animal house is designed for work with the larger animals; provision is made for the maintenance of fowls and the normal stock of rabbits and guinea pigs. Other animals, as required, are accommodated in out-houses. There are six acres of land available for pens, grazing and the cultivation of food crops for animals.

The Decline of Population

A DEBATE on the prospective decline of population took place in the House of Lords on June 21. Lord Samuel pointed out that whereas the number of live births per 1,000 women of child-bearing age was 129·8 in 1891, at the census of 1931 it had fallen to 64·3, that is, almost exactly half in the forty-year period. In the earlier period one out of every four married women between the ages of fifteen and forty-five years gave birth to a child in any particular year, while in 1931 this was only true of one in eight. Counterbalancing effects, the fall in the death-rate and the change from emigration to an inward movement of people, was far from equalling this decline in the birth-rate. He advocated family allowances as a means of diminishing the cause and desire for small families. Other measures suggested were housing estates for larger families and removal of the marriage bar in certain occupations such as bank clerks and women teachers. He advised the appointment of a Royal Commission to inquire into the whole question. Lord Snell said that the real problem is qualitative rather than quantitative and that the question of age proportion is most important. Lord Dawson of Penn said the prospective fall in population is too great even if we have regard to quality, as the country has failed to reproduce itself since 1925 and to-day 100 mothers only produce 76 girl babies or future mothers. Contraception is a specialized example of man's gradual control of natural sources and is spreading to all classes and creeds. It should be seen that parents willing to bear their quota of children should not be penalized. In tenement blocks there should be crèches, nursery schools and other necessities, and the health services should be linked up into a connected whole.

LORD STAMP said there is little popular apprehension on this subject because we are still living under the delusion of continual expansion. He pressed for a quinquennial census to provide the necessary information for a Commission. Boys between the ages of thirteen and eighteen years in England and Wales in 1938 numbered 2,100,000. In seven years this will fall to 1,787,000. The effect of this tendency is already being felt in schools. The Bishop of Norwich remarked that his predecessor a century ago had thirty-seven children while that Bishop's two brothers each had thirty-two children. Households of the better stock now have small families, for one reason, because of the necessity for domestic help in rearing a family. Lord Derwent said family allowances would be inadequate without propaganda, and that the birth-rates of France and Italy continue to decline. This is principally from incertitude regarding the future. The Archbishop of York said that while the older men who have been out of work prefer to get back to work even if their wages amount to less than their relief, this is by no means true of the younger men. They should ensure in some way that a man in work always obtained more than a man without work. Lord Templemore put forward the view that some forecasts anticipate an earlier decline of population than appears justified. For the first time since 1873, the birth-rate began to rise in 1934 and this has continued for the last five years. But too great value should not be placed on that. As regards family allowances, public opinion has not yet crystallized. The Population Statistics Act, 1938, would supply information which should throw light on the incidence of fertility in different sections of the population.

Students and Military Training

THE adoption in Great Britain of the principle of conscription and the calling up for registration of youths between the ages of twenty and twenty-one years for a period of military service has raised the question of the position of university students. As regards those proceeding to universities after October next, Mr. E. Brown, Minister of Labour, stated in the House of Commons on June 22, that at a meeting held under the auspices of the Ministry between representatives of the Committee of Vice-Chancellors and Headmasters, together with representatives of the departments concerned, it was agreed unanimously to recommend that such boys should be given the option of postponing or anticipating their liability to undergo military training. Mr. Brown said he intended "to put this agreed conclusion into operation, subject to reviewing the position in twelve months' time in the light of experience, when I propose again to seek the advice and assistance of the representatives of the universities and the schools". He also agreed to bear in mind the further recommendation that those under the age of eighteen years on January 1 of the year in which they wish to take their training should not be allowed to anticipate their military service.

Biological Expedition to Jamaica

A LARGE expedition is leaving the University of Cambridge for Jamaica this summer. It is financed by the Royal Society, the Royal Geographical Society, Mr. J. A. Steers, Gonville and Caius and St. Catharine's Colleges, Cambridge, and the Universities of Cambridge, Manchester and Sheffield. The members of the expedition are Dr. V. J. Chapman, the leader, university demonstrator in botany, Cambridge; Dr. H. Hamshaw Thomas, reader in plant morphology, Cambridge; Mr. J. A. Steers, lecturer in geography, Cambridge; Mr. J. S. Colman, lecturer in zoology in the University of Sheffield; Mr. W. R. Philipson, of the British Museum (botany); Mr. K. R. Sporne, of Downing College; Mr. J. Lofthouse and Mr. D. J. Crisp, both of St. Catharine's College. The main party is proposing to examine shore-line development in relation to the formation of coral reefs and cays and also to the salt ponds, and it is intended to make a comparison of the cays and the mode of their formation with similar structures in the Great Barrier Reef. This will be facilitated by the presence of two members of the Great Barrier Reef Expedition—Mr. Steers and Mr. Colman. Dr. Chapman will examine the botanical side of this problem, and is intending to devote particular

attention to the mangroves. A party consisting of Dr. Thomas, Mr. Philipson and Mr. Sporne is going to spend a month in the rain forest where each will carry out research on his own problems: Dr. Thomas working on the Pteridophyta, Mr. Philipson collecting, because he is one of those appointed to complete the late Dr. Rendle's "Flora of Jamaica", and Mr. Sporne investigating flower morphology. The whole expedition will return at the beginning of October with the exception of Mr. Philipson, who will stay on for a few more months.

Earthquake on the Gold Coast

EARTH tremors shook the whole district of the Gold Coast, Ashanti, Dahomey and Western Nigeria in West Africa from about 7.10 p.m. on June 22 to 4 a.m. on June 23. It is not yet clear whether there were several shocks of approximately equal dimensions from one or several closely situated epicentres, or whether there was one large earthquake with precursors and aftershocks. With the evidence available at the moment, the latter appears to be the most probable as the greatest impact of the earthquake was felt at Accra (5° 30′ N., 0° 10′ W.), Cape Coast (5° 5′ N., 1° 0′ W.), and Sekondi (4° 53′ N., 1° 48′ W.) at 7.15 p.m. on June 22. If the intensity of the shock was the same at each of these three places, as the immediately available evidence seems to indicate, then the epicentre was near 5° N., 1° W. and the focus rather below normal, or it was, say, 3·5° N., 1° W. in the Gulf of Guinea and depth of focus normal. Further evidence from the area, but more particularly the evidence of seismograms, will decide this. Many public buildings, banks, offices and native houses in the area have been damaged or destroyed, killing seventeen people at Accra, twenty-nine at Cape Coast and twenty at Sekondi, besides injuring several others. At Accra the electric lighting system was interrupted, but this was quickly remedied. An earthquake of these dimensions is an exceptionally rare occurrence, if not unknown, near Accra, and according to recent catalogues of epicentres there is no active epicentre anywhere near the present one. It is unfortunate that there are no seismographs situated nearer the probable epicentre than Algiers, Johannesberg, Cape Town and Nairobi, though the shock appears to have been sufficiently intense to have been registered at these, and by seismographs at even greater epicentral distances.

Entomological Control of Lantana

THE rapid spread of Lantana, a garden escape, in Northern Queensland has brought it amongst the serious weed pests for which the Council for Scientific and Industrial Research, Australia, is seeking methods of control. In 1935 studies of *Teleonemia lantanæ* were commenced in Fiji, where this bug had been introduced from Mexico, its native home, by way of Hawaii. As it proved harmless to any Australian plants of economic importance, it was established under quarantine conditions in Canberra in 1936. The first liberations were made late in that year in the Northern Rivers area of New South Wales, and afterwards near Atherton in Queensland, and at Rockhampton. Disappointment followed; the bugs seemed to have disappeared, until in April of this year they were reported in the Atherton district in enormous numbers over an area of some twenty-four acres. Leaves were falling from the Lantana bushes, flowers had been destroyed and in some instances up to two feet of the ends of branches had been killed as the result of the bug feeding on them. At Rockhampton also there are signs of establishment. Undue optimism is to be deprecated, and it is unlikely that similar success will be attained to that of Cactoblastis on prickly pear. It still remains to be seen whether Teleonemia can maintain itself in large numbers and whether continuous defoliation will destroy Lantana; nevertheless, the outlook is promising.

Exhibition of New Textile Fibres

AN exhibition of new textile fibres has been arranged at the Science Museum, South Kensington, and will be opened on July 3 for two months. To-day fibres possessing many of the properties of natural wool are manufactured from skimmed milk. The exhibit illustrating the stages in the manufacture of casein yarn includes several examples of fabrics, woven on worsted machinery. Another group of exhibits includes yarns and materials as produced by the viscose and cellulose acetate methods. These are generally termed rayon or 'artificial silk'. By modification of the spinning processes it is now possible to manufacture exceptionally strong yarns of this material, and some of the applications are illustrated by such articles as a section of a motor tyre showing the cord reinforcement, 'doped' aeroplane fabric, fine gauge hose, sail cloth, etc. An interesting American exhibit shows a new type of cellulose acetate rayon in which the fibre is characterized by an inherent stabilized crimp, producing a yarn the behaviour of which is comparable in some respects to that of wool. One of the most important textile discoveries of recent times has been that of nylon. This is a truly synthetic yarn and is the first textile fibre prepared wholly of raw materials from the mineral kingdom. Although derived from coal, air and water, nylon can be produced in filaments of exceptional strength or as fine as a spider's web, yet having elasticity and lustre. Another striking development is to be found in the use of glass fibres. Objects showing this class of fibre include woven and knitted fabrics made entirely of pure glass with a collection of articles indicating the commercial applications. An exhibit of interest from Tokyo shows fibre and yarn produced from seaweed. Jute, sisal, and hemp are each represented, with examples of the latest types of yarns and materials produced from these fibres.

British Museum (Natural History): Acquisitions

RECENT acquisitions in the Department of Zoology include a collection of Northern Rhodesian mounted heads and skulls of ungulates made chiefly at Mpika

by the late Mr. F. H. Melland and presented by Mrs. Melland. The collection contains some very fine sable and roan antelope heads and is of special interest in that the species represent a transition stage from the southerly types of South Africa to the more northerly forms found in Tanganyika Territory and Kenya Colony. Another interesting gift is the skull of a hippopotamus from Nigeria presented by Mrs. Piper. Purchases include a large collection of South American mammals from Dutch Guiana, and another from Ecuador. The latter is worthy of special mention since it contains a series representing that most interesting genus of Diprotodont marsupials, Caenolestes. The Department of Mineralogy has received a series of specimens of Darwin glass from Mt. Darwin, Tasmania, collected and arranged by the late Mr. Hartwell Conder and presented by his widow. Darwin glass is a silica glass. Thousands of tons of it in the form of rounded and rod-like pieces are found over an area of sixty square miles in Tasmania. It is believed that the silica-glass was formed by the heat engendered by the impact of a large meteorite. Some crystals of the rare mineral withamite, a pink variety of epidote, have been presented by Mr. W. G. Myers, who found them at the type locality in Glencoe where the new road has cut through the lavas in which withamite occurs. Good crystals of this mineral are rare. A very large rough crystal of microcline feldspar from Norway has been purchased. This crystal measures about $14 \times 12 \times 10$ inches and weighs about 100 pounds.

Report on Abortion

THE report of the Inter-Departmental Committee on Abortion, which was appointed by the Minister of Health and the Home Secretary under the chairmanship of Mr. Norman Birkett, K.C., has been issued (H.M. Stationery Office. 2*s*. 6*d*. net). In the Majority Report, signed by fourteen members, the question of the prevalence of abortion is first examined. They stress the difficulties entailed in arriving at any estimate; but suggest that the number of abortions occurring annually in England and Wales is between 110,000 and 150,000, of which perhaps forty per cent are criminal. The Committee discusses the existing law, analyses the motives for criminal abortion and the methods employed, and examines proposals for amending the law. It recommends that the law should be clarified so as to make it plain that the induction of abortion is legal when the operation is carried out to save the life, or to prevent impairment of health, of the pregnant woman, but expresses strong opposition on ethical, social and medical grounds to any broad relaxation of the law. It is recommended that therapeutic abortions should be notifiable by the operator to the medical officer of health, and that there should be some restriction on the sale of abortifacient drugs. The majority of members of the Committee are not prepared on general grounds to recommend the unrestricted dissemination of birth control advice by the public health services.

The New Radcliffe Observatory

IN *Occasional Notes Roy. Astro. Soc.* (No. 4, March 1939), Dr. H. Knox-Shaw gives a very full description of the work on the erection of the 74-inch reflector at Pretoria, and three plates illustrate various parts of the equipment, the turret, the telescope itself as viewed from the north-east, and also the Newtonian observing carriage and the Coudé room. It is satisfactory to know that the pyrex disk for the large mirror has been successfully cast and the figuring will be completed in a few months, after which the mirror will be sent to Pasadena for aluminizing. It will be possible to use the telescope at three foci, Newtonian, Cassegrain and Coudé, the focal length in the first case being 30 feet, and the equivalent focal lengths in the last two being 111 ft. and 173 ft. respectively. The Newtonian focus will be used for direct photography and the other two for spectroscopic observation. A two-prism spectrograph for use at the Cassegrain focus is under construction and will soon be ready, and a projection measuring machine and also a microphotometer have been made for the Observatory. It is anticipated that the full programme of the work will be undertaken early in 1940, and the initial programme will include the determination of the radial velocities of the *O* and *B* type stars in the portion of the galaxy beyond the reach of the northern observatories. The object of this research is to corroborate present views on galactic rotation. When opportunities occur, photography of the nebulæ south of $-40°$ declination will be undertaken.

Museums and Children

THE revival of museum efforts which in Great Britain has followed upon the Miers report, has fortunately included in its sweep attempts to increase facilities for the interest and education of the young. But in this aspect of museum work America undoubtedly leads the way, and everyone interested in juvenile education must be grateful to Miss Ruth Weston for her impressions of American methods which appear as a supplement in the *Museums Journal* (**39**, 93, May 1939). Her first impression is one of the bold conception, enterprise, and general 'aliveness' which have produced such museums. Some are special children's museums housed in their own special buildings, in several instances right away from any other museum. Others form sections of larger museums, with special exhibition and other rooms for juveniles, either as an isolated wing or included within the main building. Sometimes the show galleries are supplemented by club rooms, library rooms, reading rooms, and a lecture theatre, which in Boston Children's Museum can seat more than 500. Loan collections of natural history objects for schools and even for individual child borrowers (as at Brooklyn), loan art collections, recording in colour and in black and white the development of art in different periods and countries (like the 2,000 reproductions at Toronto Art Gallery), have become the order of the day in these progressive museums. Much has been done in some British museums, but

much more must be accomplished if museums are to play their part in the educational system; and there should be the less hesitation in transforming some of the now existing severe and aridly didactic galleries into simplified children's galleries, since our observation is that adults enjoy and benefit from the children's exhibits as much as the children themselves.

The World Power Conference

THE annual report of the World Power Conference for 1938, prepared by the Central Office of the World Power Conference, 36 Kingsway, London, W.C.2, has just been issued. There was a meeting of the International Executive Council in Vienna during August 29–September 1, attended by more than a thousand persons from thirty-seven different countries. The British Council was officially represented by Sir Harold Hartley and J. M. Kennedy. The British delegation numbered ninety-three and was nearly double the size of any other visiting delegation. Approximately two hundred papers were presented at the meeting. It is hoped to publish these papers and the discussions on them this year in the *Transactions of the World Power Conference*. A new national committee has been formed for Algeria, and there are now forty national committees. In response to an invitation issued and accepted in 1936, the second Chemical Engineering Congress of the World Power Conference will be held in Berlin in 1940. At the same time and place the third Congress on Large Dams will be held. The questions to be discussed have already been fixed. By invitation of the Swiss National Committee a meeting of the International Executive Committee will be held in Zurich shortly.

"Micro-entomology" at Stanford University

WE have received several parts of the journal entitled "Microentomology: Contributions to Entomology from the Natural History Museum of Stanford University". This periodical is now in its fourth volume, and it only publishes papers emanating from the Museum just named. The text is from manuscript expressly typed by the Stanford University Press and reproduced by the photolith method. This type of publication has been adopted as a partial solution of the prevailing high costs of printing by monotype and hand-set type. The reproduction has been admirably carried out, but the main factor in the process is the perfect typing of the copy, since the method affords little or no opportunity for errors and corrections. Among the papers published in this journal is a series of articles on the Coccidæ by G. F. Ferris and collaborators. These are well and clearly illustrated and, in fact, illustrations form the notable feature of this publication, the saving on printing costs allowing for an unusually large number.

New Seismological Observatory

IT is learned from *Earthquake Notes* (10, No. 4, April 1939), published by the Eastern Section of the Seismological Society of America, that a new seismological station is soon to be established at Bogotá, Colombia, South America. It will be at a height of some 2,800 m. above sea-level in the Northern Andes, and will thus be one of the highest in the world. This is made possible by a grant from the Carnegie Corporation of New York to the Jesuit Seismological Association, and the director of the station is J. Emilio Ramírez, S.J., of St. Louis University. The new station will fill a very noticeable gap in the map of seismological observatories, and will supply a definitely seismic area with important observational facilities.

The Lister Institute of Preventive Medicine

THE annual general meeting of the Lister Institute of Preventive Medicine was held on June 16 when the governing body presented the Institute's forty-fifth report. This contains a survey of the Institute's activities, with financial statement and the staff changes, during 1938, and a summary of the research work pursued. Studies on viruses are prominent, and Dr. Eagles has investigated a possible virus factor in the causation of acute rheumatism. Serological investigations include further work by Dr. Felix on the antigenic structure of the typhoid bacillus and on the standardization of therapeutic anti-typhoid serum, and a study by Dr. Muriel Robertson on the immune reactions *in vitro* of certain ciliate Protozoa. The nutritional value of buckwheat and its sensitizing action to light has been studied by Dr. Chick, and the results suggest that the nutritive value of the proteins of wheat are inferior to those of buckwheat. The National Collection of Type Cultures of Micro-organisms is housed at the Institute, and during the year some 6,300 cultures have been distributed, and many new strains deposited for maintenance.

National Baby Week

THE National Baby Week Council (117 Piccadilly, London, W.1) announces that 'National Baby Week' will be celebrated during July 1–7. Propaganda this year will be concentrated on "Fathercraft in the Child Welfare Movement", and the "William Hardt" challenge shield is offered for competition among senior girls in public elementary schools studying infant care. Full particulars may be obtained from the Secretary.

International Exhibition of the Art of Greater India

THE ROYAL ACADEMY, in collaboration with a number of connoisseurs of Indian art, is arranging to hold in January–March, 1940, an International Exhibition of the Art of the Indian Empire, French Indo-China, Netherlands, India, Burma, Malaya, Siam, Afghanistan, Tibet and Nepal. It is believed that the museums and private collections of those European powers most closely connected with the regions of Indian influence can furnish an exhibition of surprising interest and value, which would serve as a prelude to an exhibition of Indian art, drawn mainly from collections in Asia, to be considered when more settled conditions give a reasonable

(*Continued on page* 29)

NATURE

SUPPLEMENT

Vol. 144 SATURDAY, JULY 1, 1939 No. 3635

HISTORY IN THE ARCHIVES OF THE ROYAL SOCIETY*

By Sir William Bragg, O.M., K.B.E., Pres.R.S.

THE archives of the Royal Society are rich in materials that illustrate various aspects of the history of the last three centuries. They have, of course, a special character, since they refer almost entirely to the matters in which the Society has concerned itself, grouped under the general title of "The Improvement of Natural Knowledge". But these matters have increased in importance with the passing years and are now a subject of the first concern of the whole world. The effect of science upon social relations and social conditions has become very great, and the gains are obvious. Yet science does not appear to be in all cases beneficent. It has become a matter of anxious consideration whether or no the increase in the knowledge of Nature must necessarily bring evil as well as good. Is there a fault to be remedied, and if so, where does the fault lie? These questions have roused a debate which is even now in progress, and some hard thinking is being given to them.

It is of some help, I think, to consider the steps by which the present position has been reached, and the Royal Society archives may be used to provide the necessary illustrations.

A few 'virtuosi', to use the contemporary phrase, who met for discussion and experiment in the middle years of the seventeenth century, were weary of the miseries of the civil war, and were glad to turn their thoughts to the consideration of natural phenomena over which the passions of men had no influence. Experimental science had long tempted thoughtful minds, and now the first founders of the Royal Society threw themselves with thankful relief into a work which seemed to them to be both a pressing duty and an absorbing occupation. They were like boys let out of school rushing out into the surrounding world to explore brooks and hedges and anything that seemed interesting. When I take down the first volumes of the *Transactions* from the shelves or look through the early manuscripts at the Royal Society, I feel as if I was turning out schoolboys' pockets and finding the usual assortment of mixed oddities.

Early Activities

In its first efforts, the Society was mainly concerned with the collection of information. The leading fellows sent questionnaires to various parts of the world which in their demand for comprehensive detail would have done credit to any inquisitive department of a modern Government. An admirable example is to be found in the series of questions drawn up by Lord Brouncker and Mr. Boyle and approved at one of the earliest meetings of the Society; in which most appropriate suggestions were made as to what should be looked for on an ascent of Teneriffe. It shows no little knowledge and penetration to inquire whether a "filtre or siphon" would work as well at the top of the mountain as at sea-level, whether a bell or watch or gun would give the same sound, a flame have the same appearance, whether a pendulum clock went at the same rate, whether birds of heavy flight would fly as well or better or worse, and so forth. It was quite apt to ask what alterations would be found in living creatures carried to the top, both before and after feeding, and "what the experimenters do find in themselves as to difficulty of breathing, faintness of spirits, inclination to vomit, giddiness, etc."

On March 28, 1672, Lord Henry Howard presented the answers to a series of questions on

* From the second Pilgrim Trust Lecture, delivered before the U.S. National Academy of Sciences on April 24.

Barbary, where a retainer of his had recently been travelling : a remarkably pictorial account of the country and its inhabitants. It was expected apparently that some traces of the arts and sciences were to be found there, no doubt because it was known that the Arabian races had handed on the knowledge of the Old World to the New. But there was no learning at all. In particular "there were no chemists except Jews and Christian slaves that distilled brandy in jars". So, too, a good account is given of Hudson's Bay and its people by a Captain Guilliaume and a Mr. Bailes, who had recently voyaged there. Naturally most of the information relates to navigation and trade, but it is interesting to find also an account of the 'Maneto' or supreme power and of his priest the 'Pawaw'. The early records contain many such questionnaires and replies thereto.

Robert Boyle was the centre of a vast correspondence on scientific and other matters, and fortunately a large collection of his papers is possessed by the Society. Many or these have been published in his well-known "Life and Works". Quite a number of them crossed the Atlantic, and you will not blame me if I choose some of them to illustrate what I have to say. They were in the main of the informative type on which such great value was set. Thus a certain 'P.S.' writes from Virginia on August 29, 1688, describing humming birds, wampum, roanoke and pook, the latter being forms of currency. The trade measurement of length was the primitive cubit. The climate of New England was a frequent topic ; it was supposed to be changing for the better. Perhaps under improving conditions the settlers were less susceptible to its rigours.

The governor of Boston, Leverett, and the deputy governor, Symonds, with other of their fellow citizens, write to Boyle in protest against charges of disloyalty to the King, anxiously rebutting accusations of neglecting the baptism of infants and so forth. In 1682, Hezekiah Usher begs the remittance for twenty-one years of the King's claim for one fifth of all minerals recovered, so that prospecting may be encouraged.

Boyle's correspondence was, as the last two extracts show, by no means confined to scientific matters. After all, the first founders of the Society were either statesmen themselves or closely connected with statesmen, and might well be supposed to be proper persons to be entrusted with important news. Thus Richard Wharton writes from Boston, warning Boyle that the French are working round the interior of the settlements towards Carolina and the South. In 1684, Randolph writes from New England of the possibility of drawing on the vast forests of Maine for supplies of masts and timbers for the navy, and discusses methods of making pitch and resin which are a secret of the French. John Winthrop writes in the same strain urging the Royal Society to approach the Government on the matter : he explains that there are sawmills handy to rivers, houses and provisions for workmen who may be sent, that small ships up to 400 tons have already been built. The supply of timber for the Navy was one of the greatest anxieties of Great Britain, from the time of this correspondence until steel replaced wood. Dry rot was a terrible curse from which the navy suffered more than the merchantmen, because the latter were more often aired and open to inspection during loading and unloading. A strange story of its ravages has recently been told by Ramsbottom in the *Essex Naturalist* (vol. 25). Among the incidents is the probable failure of the *Speedwell* to accompany the *Mayflower* on account of dry rot.

It is well known that Boyle was deeply interested in the conversion of the Indians and that the Society for the Propagation of the Gospel owes much to his initiative. In 1664 he receives a letter from John Endicott, of Boston, describing the progress of the mission. John Eliot, also of Boston, writes frequently, expressing deep gratitude, and hopes for further help. His address to Boyle was always eloquent, as for example "To the Right Honourable Learned abundantly charitable and constantly noursing Father".

In modern times it is an honour and an honour only to be elected a correspondent of a learned society. But a correspondent of the Royal Society in its early days was expected to correspond. When Cotton Mather was advised that he had been elected a fellow, he wrote in 1715 to his friend Richard Waller, the Society's secretary—the letter is in the Society's archives—saying that

> ". . . the tendency [of the Society] to Refine and Sweeten the minds of men, and reconcile them unto Just Regards for True Merits in one another, with an extirpation of that noxious clamour the party spirit, and finally how generously the more polite Literators of the world go on in it, with a decent contempt on the Banters of the Bruitish among the people, but the result of his consideration will be that it will be a greater honour to be taken into the list of your servants, than to be mixed with the great men of Achaia.
>
> "One who is entirely of that opinion, having been so listed with you has been desirous to discharge his obligations by agreeable assiduities, and therefore besides what every year brings you from him as an addition of Curiosities to the rich and vast assessment you are preparing he has bestowed a few hours upon the Philosophical Religion which he now humbly tenders to your acceptance."

The "Curiosities" here referred to became a famous object of interest in London ; the collection

was known as the "Repository". It grew to so great a size that the Society found it unmanageable, and handed it in 1782 to the British Museum, which had been founded a few years before in order, in the first place, to contain the collections bequeathed to the nation by Sir Hans Sloane. Sir Hans was president of the Society from 1727 until 1741.

The "Banters of the Bruitish" must clearly refer to the scornful comments of many clever men who did not sympathize with the experimental study of the world, who resented the intrusion of the new knowledge and laughed at the apparent futility and irrelevance of its beginnings. If they did not foresee the magnitude of its consequences, they were little more at fault than the experimenters themselves. How could intelligent men waste time on objects so small that they must be examined under the microscope? Or on the consideration of such intangible substances as the air? How could they give serious attention to the abnormalities and monstrosities that idle correspondents thrust upon them? Of course, the Society did at first give its time to many accounts that even then must have looked ridiculous to men of a serious and settled mind. There were, for example, reports of a calf that had its hair inside out, of a man who squinted only on alternate days, of another who could not see if his hair were suffered to grow more than an inch long. It must have been quaint hearing when Dr. Tyson, at a meeting of the Society, declared that one of his teeth having been drawn at Oxford some years before had been replaced and had apparently taken root again, since it was still of use. In those early days of inquiry it was of course necessary to sift all information that came to hand, but it would certainly be difficult for the unscientific mind to see the point in all cases.

Application of Research

These oddities were, however, an insignificant part of the Society's proceedings. Of far more importance among the Society's early papers are such as deal with the pressing questions of the day. Navigation claimed much attention. I have already referred to the anxieties respecting a sufficient supply of masts for the navy. Perhaps the Dutch and French were aware of those difficulties when, as Ramsbottom remarks, they were accustomed to fire high in a sea fight.

At the end of the seventeenth century, ships were growing considerably in size, since now they must become accustomed to the crossing of the Atlantic. Many English ports were unable to provide water of sufficient depth at all states of the tide, and tide tables were urgently required. Their calculation required the co-operation of mathematicians and astronomers. The archives contain of course many communications relating to the foundation of the Royal Observatory at Greenwich.

Pepys, when he was president of the Society, begged continually for information on any matter whatever that might assist him in his care for the navy. Probably he was really disappointed when Sir William Petty's double-bottomed ship turned out so badly, though he had made his bet that it would. Petty, a very able man, had supposed that a ship resembling in form two ships lashed side by side would stand up to a cross-wind better than a ship of ordinary design. The idea was that, of course, which is embodied in the outrigger of some Polynesian races. Again, there is an interesting note in the account of the *Proceedings* of July 28, 1686.

". . . it was remarked that sheathing with lead was the best expedient [for preserving ships from the worms] and found to be so by the experience of Sir Anthony Deane; but that the carpenters finding it against their profit opposed it by affirming that the iron of the pintles of the rudders of ships so sheathed were much more apt to be corroded by the sea water than those sheathed with wood which yet was a groundless supposition."

The carpenters had more reason than was supposed; we know now that electrolysis can be exceedingly troublesome.

So also the ventilation of coal mines was an urgent question, and is frequently referred to in the archives. It had become necessary to dig deeper than before. The accumulation of water became a serious hindrance and the many noxious damps were often fatal. Air pumps and water pumps are dealt with in numerous well-known papers by Boyle, Hooke, Papin and others. Sir Robert Moray wrote on the ventilation of mines in Belgium. There was much correspondence on the subject. Its general character may be illustrated by an extract from a letter which a certain Dr. Jessop of Yorkshire wrote to the Society in 1675. Let me give it in its original form, which now sounds so quaint.

"There are four sorts (of damp) common in these parts. The first is *Ordinary Sort* of which I need not say much being known everywhere: the external signs of its approach are the candles burning orbicular and the flames lessening by degrees until it quite extinguish; the internal, shortness of breath. I never heard of any great inconvenience which anyone suffered by it, who escaped swooning. Those that swoon away and escape an absolute suffocation are at their first recovery tormented with violent Convulsions, the pain whereof when they begin to

recover their senses, causeth them to roar exceedingly. The ordinary remedy is to dig a hole in the earth and lay them on their bellies with their mouths in it: if that fail they tun them full of good Ale: but if that fail they conclude them desperate."

These few extracts from the records of the Society will serve, I hope, to convey an impression of the character of the Society's activity in its early days, when first an organized attempt to collect knowledge by experiment and observation began to exercise its influence. At whatever point one picks up the story as it is told in these old records, one finds it full of interest, which lies not only in the subjects that are dealt with, but also in their relation to the activities of the time, and to the men themselves whose handwriting lies before one.

It is to be observed that these records are easily read by an educated man. Those who wrote them had in general no thoughts which the educated man could not follow, nor was it necessary to use terms which were not in ordinary use. Newton's "Principia" would, of course, be intelligible to a small number only, but in general the 'virtuosi' spoke a common language. The days of specialization and division into separate societies had not begun. How great is the contrast with the publications of a modern learned society!

It is also to be observed that there is no strict reckoning of services rendered, and no calculated recompense. Men like Hooke and other immediate servants of the Society were paid for their work, as was necessary and right, though the amount was incommensurate with their deserts. But the labours of the enthusiastic fellows and of their correspondents in all parts of the world were given freely. Indeed the Society had no money to pay with. It received no financial assistance from the Government, and the fellows' subscriptions (which, by the way, the treasurer found it remarkably difficult to collect) covered only the necessary expenses of the meetings. When the Society decided to print the "Principia", Dr. Halley himself provided the necessary funds. To this day, the fellows give without reward the services which their connexion with the Society entails. But I do not ask for any special commendation; the point is that such free service is common among learned societies, and is certainly a chief reason why they are held in respect.

The general intelligibility of the communications to the Royal Society persists for a long time. The calculations of the astronomers, the mathematicians, opticians and so forth appealed naturally to a limited number, but still we may suppose that fellows were able to understand the most part of that to which they listened. Perhaps it may be said, broadly, that the change begins when new terms must be invented to describe the increasing complexity of observations, and new units for quantitative description. Electricity and magnetism have been chiefly responsible; so that the experiments on frictional electricity which were so popular in the middle of the eighteenth century are especial objects of interest.

The progress of the subject is illustrated in the Society's archives by the many papers and letters of Watson, Franklin and others. Franklin's communications came by way of his friend Collinson, who gave them to Watson for presentation to the Society. Watson was himself a keen student of frictional electricity; and it would seem that some of the important experiments were made by Franklin and himself independently. But Franklin was, of course, the greater man, and Watson gave him full praise: "Although there are in the work some few opinions in which I cannot perfectly agree with him I think scarce anybody is better acquainted with the subject of electricity than himself."

Franklin was advised by his friend Mitchell that the paper on the subject of the identity of the lightning flash with the sparks of the electrical machine was received with laughter by the Royal Society. But the records in the *Journal Book* and elsewhere seem incongruous with such an occurrence. The warmth of Watson's praise, though he was an independent worker, his recommendation that Franklin's papers should be accepted, the repetition of Watson's commendation by the president when awarding Franklin the Copley Medal all go to show that there was probably no more than a hesitation to accept Franklin's view of the particular paper to which Mitchell referred; and the absence of some papers from the *Transactions* may well have been due to an arrangement with Collinson, who regarded the communications which he had received as private letters. At that time the *Transactions* of the Royal Society were not printed by the Society itself, but privately and independently.

The many papers in the archives that refer to frictional electricity form in themselves an interesting collection, showing the keen interest felt in the phenomena by experimenters in Europe and America, and they give additional strength, if it were needed, to Franklin's great reputation.

Activities in the Eighteenth Century

Electricity was already, in the middle of the eighteenth century, offering a new field of experimental inquiry, and the importance of it was becoming realized. In the words of Martin Folkes, president from 1741 until 1752:

"Electricity seems to promise an inexhaustible Fund for Inquiry: and sure *Phenomena* so various and so wonderful can arise only from Causes very general and extensive, and such as must have been designed by the Almighty AUTHOR OF NATURE for the Production of very great Effects, and such as are of great Moment to the System of the Universe."

The numerous papers on frictional electricity form one of the most interesting sections of the archives during the eighteenth century.

The Society's membership did not equal in brilliance that of the centuries that preceded or followed. But there were several great subjects of consideration besides that in which Franklin made so prominent a figure. A large collection of Fahrenheit papers shows the interest taken in thermometers in the earlier part of the century. Another large collection deals with inoculation against smallpox. At the end of the century, Rumford describes his beautiful and valuable experiments on heat: he is prolix of words, but he makes excellent reading. He was, of course, a pioneer in the experimental study of the nature of heat. His work is well illustrated in the Society records. At the turn of the century the chemical investigations of Humphry Davy introduced a brilliant period in British science, and these also are well recorded.

The first quarter of the nineteenth century was not, however, a happy time for the Society. Internal dissensions and unchecked growth of membership, and the formation of societies which intended to take over special sections of the Society's work, until then unrestricted, all tended to reduce the value of the records and their interest. There were denunciations of the management and laments over the decline of science. Yet one of the greatest periods of scientific discovery had already begun, with Young, Fresnel, Davy and Faraday. But now the language began to be more difficult to the uninitiated. When the phenomena of electricity, magnetism, chemistry, light came to be studied in their mutual relations, the new world in which they figured was difficult of entry. This was not only because ideas were new and could only be represented with the aid of analogies, such as current, pole, capacity and the like, but also because new terms had to be invented to provide labels for conceptions which had never entered men's minds before. What, for example, could such words as anode and cathode mean to the non-electrician? So the ordinary reader is left behind, and the language of science becomes rapidly specialized.

It is interesting to observe the care with which Faraday chose his terms. He was in the habit of consulting Whewell, the master of Trinity College, Cambridge; the correspondence is preserved in Trinity College Library and in the Royal Institution. A letter in the possession of the Royal Institution reads as follows (Whewell is replying to Faraday):

". . . I still think *anode* and *cathode* the best terms beyond comparison for the two electrodes. The terms which you mention in your last shew that you are come to the conviction that the essential thing is to express a *difference* and nothing more. This conviction is nearly correct, but I think one may say that it is very desirable in this case to express an *opposition*, a contrariety, as well as a difference. The terms you suggest are objectionable in not doing this. They are also objectionable it appears to me, in putting forward too ostentatiously the arbitrary nature of the difference. To talk of Alphode and Betode would give some persons the idea that you thought it absurd to pursue the philosophy of the difference of the two results, and at any rate would be thought affected by some. Voltode and Galvanode labour no less under the disadvantage of being not only entirely, but ostentatiously arbitrary, with two additional disadvantages; first that it will be very difficult for anybody to recollect which is which; and next that I think you are not quite secure that further investigations may not point out some historical incongruity in this reference to Volta and Galvani. . . .

"I am afraid of urging the claims of *anion* and *cation* though I should certainly take them if it were my business—that which *goes to* the *anode* and that which goes to the *cathode* appearing to me to be exactly what you want to say. To talk of the two as *ions* would sound a little harsh at first: it would soon be got over."

The selection of the terms anode and cathode were based on a suggestion made by Faraday. In order to obtain a description which he could remember, he supposed his electrolytic trough to be placed parallel to the equator, and the current in the trough to run in the direction in which a current would have to run round the earth in order to give to the earth its observed magnetism. This implied that the current ran from east to west. It came, therefore, from the sunrise and went to the sunset, and the terms anode and cathode were taken as describing the way of the sun in the morning and in the evening.

Many groups of papers in the archives relate to work done for the Government, or for national enterprise, eclipse expeditions, biological and geodetic expeditions and so on. There is an interesting bundle of Sabine papers which have not yet been published. Sabine (1788–1883) was largely responsible for magnetic surveys in various parts of the world. Not a little of it is concerned with New England. There are letters from G. P. Bond, of Cambridge, the astronomical observer of the American Academy of Arts and Sciences, discussing the magnetization of the earth; from

I. M. Gillin, of the Observatory at Washington; T. D. Graham, of Baltimore; A. D. Bache, belonging to the Coast Survey, and so on. A letter from the secretary of the American Academy announces the appropriation (April 22, 1840) of 1,000 dollars for the purchase of instruments recommended by the Royal Society.

I shall say nothing of records more recent. We are all familiar with the bold advance of modern science, and extracts from the archives relating thereto would be superfluous. Specialization continuously increases. Papers become ever more complicated, each appealing only to a fraction of the scientific world and not at all to the general reader. The change from early times is very great indeed. It is inevitable and it implies success in experiment and deduction. But its effects are serious and must be examined carefully.

Science and Society

These extracts show, I think, that the archives furnish a rich commentary on the history of the period during which the Royal Society has been in existence. They show, too, that the Society has played no small part in the doings which that history records. The new spirit which gave rise to the Society demanded that action should be based upon experimental research, and however spasmodically the world as a whole has obeyed this new principle, however ignorant men of all kinds, rulers and ruled, have been of the working of the leaven, the change in the ordering of men's activities has proceeded steadily and strongly. It has grown as the roots grow underground, preparing the life of the plant when the time comes for it to flourish. That time is already here, if we may judge by the extent to which natural knowledge is now used in all that men do.

We now observe the flower and the fruit that it bears. As we all know, we have reason both for satisfaction and for anxiety. We do see the happy results of a better acquaintance with Nature in a greater freedom from disease, in a richer life, in new opportunities for the exercise of talent, in a wider outlook. On the other hand, the problem of the well-being of the community is still far from complete. Not long ago the American Association for the Advancement of Science met in Richmond, Virginia, to hear a noble address from its president. The very title of his address, "Intuition, Reason and Faith in Science", was an indication of the position from which many of our most thoughtful scientists regard the problem as it stands to-day. From our side of the water we were glad to send Sir Richard Gregory to show that we also are trying to take our bearings for a new advance. We cannot stand still, of course; we must go forward, even though the way is not clear. We know the strength of science, we see that it has done great things, and are confident that its powers can be employed with greater and greater success as we give our whole minds to the problem that we have to solve. How shall we ensure the right use of natural knowledge, give full play to its beneficence and prevent its abuse? You and we and, let us hope, all associations of scientific men the world over, are of one mind in this matter, and are glad of the strength that unity brings.

The very fact that we share this goodwill points to the road that we must take. The goodwill that is based on our mutual understanding of what we are striving for is somehow to cover the world. I have not of course the presumption to say that science is by itself to leaven the whole. There are other incentives to co-operation; first and foremost stand the binding forces of pure religion. But the co-operation of the scientific workers is a new leaven, though it is not the first in the field. It is our own contribution which, if we can make, we must make or we fail in our duty to the world. I assume that we accept the duty.

We can surely conclude, from what we learn in the accumulated accounts of their doings, that the learned societies have not been unmindful of this primary purpose. No doubt in the early days when men collected facts as matters of interest, the recitals to which they listened were to many of them a private benefit only. Yet there were always men of wider vision who saw also the future benefit to their country or the world in the ordering of natural knowledge. The archives of the Royal Society, into which I have dipped here and there in order to provide illustrations of my argument, show the continuous endeavour of a body of men of science to be of help to their fellowmen. They may not have been always conscious of such an effort; in any community you may find some who are purely selfish. But as a body of men, vivified by those who had in them most of the right spirit, they have played a great part and I believe firmly a beneficent one.

We cannot but ask ourselves whether it is possible to say that such and such actions and dispositions of societies like yours and ours have been the dispensers of good, while others are to be set on the opposite side. Some results derived from science are good: some already are bad. Are these antitheses related to similar opposites in our work as scientists?

Most thinkers now agree that we are not responsible for the uses that are made of the knowledge we find. We cannot control the strong passions that seize upon discoveries for selfish purposes. The work of discovery goes on and no one can stop it, not even ourselves. The constant

demand for knowledge that is required for the solution of problems in health, in industry, in every human activity is so insistent that knowledge increases continuously and rapidly; and even if there were not this practical urge, there would be the never-failing curiosity to know more. We must therefore accept the position; we all seek for an understanding of how to make the best of it.

Exposition of Scientific Research

I have referred already to the addresses given recently by Dr. Birkhoff and Sir Richard Gregory. They illustrate a movement which gathers strength. It is based on an anxious determination to find out how the new situation is to be gauged and treated, and in particular, what the scientist may do. There is so much inquiry to be made before an answer can be given to this general question that it would be wrong to anticipate a conclusion. We can only remind ourselves of a few obvious lines of action, which we take in the expectation that the less obvious will become clear.

There is the great question of right exposition. It may be that there are some who would even now disclaim any duty of scientific men in this respect; and certainly there were many who would have done so in the past. If, however, we suppose that natural knowledge and the power which it gives are a common possession of mankind, we ought to make sure that what is found is understood. We cannot compel men to make use of science in the right way, but the chance that good use will be made is in a curious way dependent on the ease with which it is stated. If its expression is in forbidding terms, the man who sees no direct benefit from the effort of facing a difficult understanding leaves it alone. On the other hand, the man who is engaged in a fight against his fellows, whether in business or in war, grasps at any advantage that knowledge gives him, if he becomes aware of it; and of late years such men have seen the advantage, whence comes much of our present perplexity. The world is horrified by the development of frightful engines of war. It observes, too, that a technical invention, based it may be on some new scientific discovery, may throw great industries out of gear and bring misery upon employers and employed. These are obvious evils, and it is not surprising that the proper desire to increase knowledge is supposed to be associated with a tendency, even a desire, to make ill use of that knowledge. Also those men of goodwill who are acquainted with scientific aims and achievements have their own peculiar distress, because they know how little is done for the general good, compared to what could be done.

Exposition, therefore, becomes one of our chief concerns. It must be mated necessarily with the understanding that appropriate education can provide. We desire that all men, and especially men of goodwill, and especially also men of good education who are the natural leaders, should be aware of what science is doing and can do. A certain surviving distrust based on past misapprehensions has to be cleared away and replaced by co-operation.

I was standing once on the platform of a little up-country railway station in Australia, with others who had come to share the mild excitement of the arrival of the infrequent train. There was bustle when the train was ready to start, flag-waving, bell-ringing and cries to stand back. The engine whistled loudly—and went off by itself: the coupling with the train had been forgotten. There was a moment's pause, and then a shout of laughter while the shame-faced officials set out to repair their mistake.

There is something like that in what is taking place to-day. Scientific workers are so preoccupied with their business of research—naturally so—and in their researches have gone so far, that the world has no clear knowledge of the positions that have been reached. We have to see to the coupling and take the world with us. It may seem ungracious to make a statement of this kind when so much is already being done to popularize scientific knowledge. Yet it is to be observed that much of the science which is absorbed by the people lies on planes of lower value. Some that is intended for popular enlightenment is of that kind which seeks to dazzle by the recital of huge numbers. We must, of course, learn how narrow is our knowledge if we limit it to the consideration of spaces of about the same magnitude as our own bodies, or of times comparable with our own length of days. But that is a lesson in humility; the mere staring at big figures is childish if there is nothing more.

There are scientific writings which tend to be mystical and need very careful reading, lest they seem to contain a meaning when in fact they do not. Some of the terms used to describe scientific observations are drawn from the general vocabulary, such as wave, vibration, ray, ether and so forth, and are defined or re-defined for the specific purpose. If they are allowed to carry at the same time any unrestricted meaning that can be given to them in ordinary usage, an argument which includes them gets out of control and leads to danger.

The Spirit of Research

The observations of natural science, though they have now passed far beyond the range of the unaided senses, have not left the plane in which

eyes and ears are accustomed guides. Neither they themselves not any combination of them rise to a higher plane ; that is reserved for conduct, which, however, must take account of them.

The understanding of science that should be general to all men is of a simpler kind. It rests on a knowledge of the elementary laws of Nature, so far as we can ascertain them, and an appreciation of their continuous influence upon our lives. It leads to an awareness of the general position, though not necessarily a detailed acquaintance with it. It couples us all together in the desire to learn from Nature. We enrich our own lives, and we learn how to enrich the lives of our neighbours ; but the great happiness lies in the discovery that there is a world in which we can all work together for the common good, in which there is endless work to be done, and an unselfish purpose can lead us from strength to strength.

Herein lies the finest work of science. Even the relief from pain and disability, the increase both in quality and in quantity of the fruits of the earth, the betterment of all the conditions of life, are not the end ; there is something higher. It is the mutual service that is rendered when these things are fought for, and the happiness of mutual trust and reliance, and the last great act of virtue, that is to say, the sacrifice of self. To quote from Dr. Birkhoff's address : "I would state a fundamental truth about the social level which in some sense is the highest level of all [ranking, that is to say, above four other levels which he described, mathematical, physical, biological, psychological] : the transcendent importance of love and goodwill in all human relationships is shown by their mighty beneficent effect upon the individual and upon society."

Collectively and individually, men of science have done great things. Yet their achievements have value of one kind, and the spirit in which they worked has value of another kind ; and the latter value is far more to be desired than the former. We may truly say of some of our greatest men of science that the world has gained more from their lives than from their discoveries, and this is so even if their influence on the world is limited to that which the world has been able to perceive. Their discoveries made them famous, but they themselves are better known than their discoveries. Faraday's reverence for truth and unselfish devotion to its acquisition have a higher value than the laws which he established. We gladly admit our debt to Pasteur and to the Curies, and yet the inspiration which we draw from their lives is even better than the results of their work. The world admires Franklin for his discoveries in electricity, yet it respects him more for his wisdom. I might prolong the list, but everyone can do that for himself. In brief, the spirit in which knowledge is sought and the manner in which it is used are more important, more real, than knowledge itself.

The records of scientific discovery, of the development of the fields of experiment which began three hundred years ago, have shown the growing power of science. The extent of their power is to-day a chief concern ; we must, as so many are now trying to do, give anxious thought to its exercise. The power is not actually in the hands of the scientist, though he is deeply interested in its future because he has been, and is, the occasion of its existence. It may fairly be inferred from experience that the scientist himself will never be a tyrant. His work does not rouse in him the desire to dominate, but rather to assist. Love of accuracy, patience, perseverance, self-denial have been common qualities and necessarily so. These have a place in the general esteem, and therefore have their effect. Most of all the world respects the devotion to service that has so often been found ; the warm love of their fellows which has inspired so many to give themselves and their labour without counting the return. We must hope that such a spirit will continue in ourselves, whether as individuals or as societies.

The problems of society, and in particular those into which natural knowledge enters so powerfully, will long demand a patient examination. But whatever may be the tactics that are developed in the end, it is certain that the satisfactory solution will be based upon moral influence. It is for us, as scientific workers, to supply the natural knowledge and help in its application ; but that is not the complete account of what we have to do. Our effectiveness will depend, as is shown by all human history, including our own limited experience, upon the devotion, wisdom and goodwill which we bring to our task.

PRINTED IN GREAT BRITAIN BY FISHER, KNIGHT AND CO., LTD., ST. ALBANS

prospect of successful organization. The co-operation of the French Government has been secured, and that of the Dutch Government is expected. The executive committee of the Exhibition is under the chairmanship of Sir Edwin L. Lutyens, and Sir John Marshall and Sir Richard Winstedt are vice-chairmen. The assistance of experts in the great museums containing Indian collections has been promised.

The Night Sky in July

ASTRONOMICAL twilight (the sun not greater than 18° below the horizon) lasts all night in the latitude of London until July 21. The moon is full on July 1 at 16·3h. and again on July 31 at 6·6h.; it is new on July 16 at 21h. Mars is in conjunction with the moon on July 3, Jupiter on July 9, Saturn on July 11, Mercury on July 18, and Mars again on July 30. Mercury is at greatest elongation (27° E.) on July 13, and may be visible in the evening twilight up to about July 10. Mars and Jupiter both rise in the late evening. Venus continues as a morning star, rising at 2h. 50m. in mid-July. On July 23 Mars is in opposition and near its greatest apparent brightness, −2·6m., which is brighter than Jupiter is at any time. At this opposition, the diameter of the disk of Mars subtends 24″. The least distance separating Mars from the earth on July 27 is just over 36 millions of miles. On July 17 between 4h. 12m. and 5h. 0m., Jupiter will appear without its four bright satellites. Satellites II, III and IV will disappear by being eclipsed by the parent body between 2h. and 3h., and Satellite I begins to transit the disk of the planet at 4h. 12m. At 5·0h., Satellite IV will re-appear from eclipse. The next occasion when a similar phenomenon will occur is on July 10, 1942. The ring system of Saturn is now well opened, the diameter of the minor axis of the outer ellipse of the outer ring being about 11″. Neptune, in the constellation Leo, makes a close approach on July 30 to the star B.D. + 4° 2492, magnitude 8·7; the minimum distance between planet and star will be about 20″. Amongst the meteor showers due with their maximum late in this month are the Sagittids and the δ Aquarids.

Announcements

THE Council of the Institution of Civil Engineers has awarded a Charles Hawksley Prize of £150 for 1939 to Donald Henry May, of Clapton, London, for his design of a grain-silo. Arthur James Francis has been "honourably mentioned", and a grant of £50 has been awarded to him for his design of a steel highway bridge.

ON the recent occasion of the 150th anniversary of Schiller's inaugural lecture at the University of Jena, the Society of Medicine and Natural History of Jena presented the anatomist, Prof. R. Spanner, with the bronze memorial medal in recognition of his outstanding work on anatomy, and especially his researches on arterio-venous anastomoses.

A COMMITTEE has been formed to celebrate the quatercentenary of the death of Paracelsus; it is under the presidency of Prof. Laignel Lavastine of Paris, with the collaboration of Cornil, dean of the Marseilles medical faculty, Abel Rey of the Sorbonne, Garraux, president of the Swiss Medical Federation, Cawadias of London, Verzar, dean of the medical faculty of Basel, and Anderes, dean of the medical faculty of Zurich.

APPLICATIONS for grants from the Permanent Science Fund of the American Academy of Arts and Sciences are invited for consideration by October 1, 1939. Applications should be made on special forms furnished by the Committee. Further information can be obtained from the chairman of the Committee on the Permanent Science Fund, Prof. John W. M. Bunker, Massachusetts Institute of Technology, Cambridge, Mass.

A STUDENTSHIP, established in memory of Edward Teshmaker Busk, who in 1914 lost his life while flying an experimental aeroplane, will be awarded in July. The studentship is of the value of about £150, tenable for one year from October 1; but a student may be re-appointed on the same terms for a second year. It is open to any man or woman being a British subject and of British descent who has not attained the age of twenty-five years on October 1. The object of the studentship is to enable the holder to engage in research, or preparation for research in aeronautics. Further information can be obtained from Prof. B. Melvill Jones, Engineering Laboratory, Cambridge.

THE Twelfth International Congress of Psychology will be held in Edinburgh during July 22–27, 1940. Further information can be obtained from Prof. Godfrey Thomson, Moray House, Edinburgh 8.

IN September of this year—most probably during the second fortnight of the month—Messrs. Carl Zeiss, Jena, will hold the fourth technical-scientific course of lectures on spectrum analysis, photometry, microscopy and fine measuring. During the principal lectures, new results of practical value concerning modern material-testing and fine measuring will be dealt with. Sufficient time will be reserved in the form of informal discussion for purely scientific research, and short lectures will also be delivered. This year ample opportunity will be provided for practical work with the instruments under the guidance of experts. Further information can be obtained from Messrs. Carl Zeiss, Dept. ZWA, Jena, Germany.

A FIRST supplement, covering the years 1935–36, has been issued to the catalogue of foreign books in the Tokyo Imperial University library. The catalogue is arranged in ten sections covering general and miscellaneous; philosophy, religion, education; languages, literature, fine arts; history, biography, geography; law and politics; economics, commerce, public finance, statistics, social sciences; science; engineering, industries, army and navy; medicine and agriculture. Each section consists of an author index and an alphabetical list of periodicals.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 37.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Instability of the Mesotron and the Gravitational Constant

THE recent discovery that the mesotron is unstable in free space introduces into physics a new dimensional constant, the mean life τ_0 of a mesotron at rest, of magnitude about $2{\cdot}5 \times 10^{-6}$ sec. It is convenient to consider not τ_0 but the related fundamental length $L_0 \equiv c\tau_0 \doteqdot 7{\cdot}5 \times 10^4$ cm. This length is very much longer than any of the lengths, ranging from 10^{-13} cm. to 10^{-5} cm., which can be formed out of the constants e, $\hbar$, c and the various fundamental atomic masses. Thus, without using large powers of the non-dimensional atomic ratios (for example, $\hbar c/e^2 \doteqdot 137$), it is not possible to express L_0 in terms of these constants alone.

If L_0 is to be related to the other natural constants, it is clearly necessary to include the gravitational constant G. When this is done, the following expression gives at once the right order of magnitude:

$$L_0 \sim R_0 \frac{e}{w}, \qquad (1)$$

where $R_0 \equiv e^2/\mu c^2$ and is the 'classical' radius of a mesotron of mass μ, and $w \equiv \mu G^{1/2}$ is its 'gravitational charge'. The use of w instead of G is advantageous, since it brings the gravitational forces $G\mu^2/r^2$ into the same form as the electrostatic forces e^2/r^2.

Since $\mu \doteqdot 170\ m$, where m is the mass of an electron, $R_0 \doteqdot 1{\cdot}6 \times 10^{-13}$ cm., and, since for a mesotron $e/w \doteqdot 1{\cdot}2 \times 10^{18}$, the right-hand side of (1) gives 2×10^4 cm., in rough agreement with the observed value of L_0. Another possible form of (1) is, of course, $(r_0/137)\ (e/w)$, where r_0 is the 'classical' radius of an electron.

It would be attractive to conclude from this result that perhaps the decay of the mesotron may provide a link between atomic and gravitational phenomena. This implies, on Yukawa's theory, that there must also be a connexion between gravitation and β-decay.

Nothing so far has been said of the neutrino, into which, together with an electron, a mesotron is supposed to decay. If a neutrino has a finite rest mass μ_0, this might have been brought into the calculation, and if the mass were of the right magnitude, there would be no necessity to introduce G. For example, if $\mu_0/m \sim 10^{-15}$, L_0 can be expressed simply as $L_0 \sim \hbar/\mu_0 c$. In view of (1), we have $\hbar/\mu_0 c \sim R_0 e/w$, and this would be interpreted as showing that the mass of the neutrino, as well as the life-time of the mesotron, is connected with gravitation.

There is one possibility that would make all this argument false. It is the unlikely one that perhaps the life-time τ_0 of the mesotron, as measured in the earth's atmosphere, may not be the same as that in free space, but may depend on the local conditions, for example, on the local gravitational, electric or magnetic potentials.

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June 20.

Reaction between Hydrogen and Oxygen Sensitized by Nitrogen Peroxide

NITROGEN peroxide exerts a powerful catalytic effect on the combustion of hydrogen[1]; small quantities may depress the ignition temperature by so much as 200° C. (for example, addition of 0·09 mm. NO_2 lowered the ignition temperature of 100 mm. H_2 + 50 mm. O_2 in a porcelain vessel from 580° to 370° C.). At any particular temperature the sensitized ignition is confined between readily reproducible, narrow limits of concentration of nitrogen peroxide outside which a slow catalysed reaction occurs. It was further shown[2], in this laboratory, that a simple correlation exists between the induction period found to precede the onset of both the slow reaction and the ignition, and the catalytic effect of the nitrogen peroxide on the slow reaction and the ignition. The results were interpreted by assigning to nitrogen peroxide the dual role of stimulation of chain branching, and inhibition by the direct termination of chains. This stimulation of branching may be visualized if we suppose that the nitrogen peroxide, by participation in a collision with some highly energized link of the chain, is dissociated and gives rise to an oxygen atom.

The fact that induction periods precede the slow reaction as well as the ignition, and that the plot of induction period against concentration of nitrogen peroxide shows no discontinuity as the ignition points are passed, shows that even in the region of slow reaction the system possesses a positive 'net branching factor φ'. This positive value of φ leads to an exponential increase of the number of centres with time, and at the end of the induction period, when their number increases very rapidly, these become increasingly subject to removal by recombination in three-body collisions, a process which depends on the square of the concentration of centres. Through the interplay of branching and self-neutralization, the number of centres and hence the reaction rate, thus tend to potential equilibrium values. It was concluded[3] that ignition only occurs when some critical volume element becomes self-heating; a condition which intervenes when the potential equilibrium concentration of centres reaches a critical value.

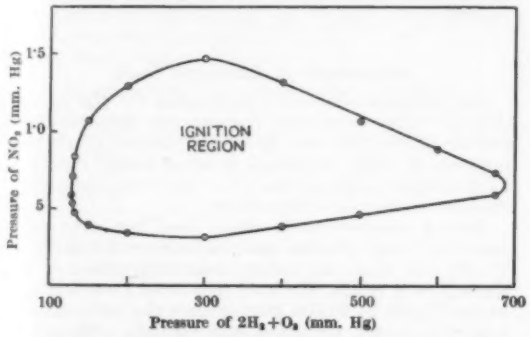
Additional evidence for this point of view is now provided by the study of the effect of pressure of reactants and foreign gases on the induction period and ignition limits.

(*a*) *Foreign gases.* Addition of foreign gas to an explodable mixture of hydrogen, oxygen and nitrogen peroxide of constant composition, progressively lengthens the induction period and eventually converts the ignition into a slow reaction. For four foreign gases the relative amounts necessary to quench ignition are :

$$A : N_2 : He : CO_2 :: 6 : 3{\cdot}6 : 3 : 1.$$

The order of effectiveness in lengthening the induction periods is the reverse of this. These results are explained if the foreign gas can alter the net branching factor φ by deactivation of energized chain centres, which would otherwise lead to branching by collision with nitrogen peroxide molecules. Further analysis of the results indicates that, in the case of helium, the high thermal conductivity may also enter as a major factor determining the ignition condition.

(*b*) *Pressure of reactants.* At a given temperature, increase in the pressure of reactants causes the upper limit to rise to a maximum and then to fall ; whilst the lower limit, though less dependent on pressure,



falls to a minimum and then rises. The accompanying diagram shows the effect of pressure on the limits in a pyrex vessel of internal diameter 7·0 mm. at 364° C. This result is readily interpreted on the thermal theory. The fact that increase of pressure progressively shortens the induction periods to an almost constant low value, indicates that the explodability of the mixture as measured by the net branching factor progressively increases to an almost constant value. To this cause must be attributed the initial widening of the explosion region. At higher pressures, however, the increased probability of recombination of centres in three-body collisions decreases the equilibrium reaction rate and causes the explosion region to shrink.

A more complete account of these and related experiments, together with a quantitative development of the theory, will be published elsewhere.

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F. S. DAINTON.

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May 30.

[1] Thompson, H. W., and Hinshelwood, C. N., *Proc. Roy. Soc.*, A, **124**, 219 (1929). Norrish, R. G. W., and Griffiths, J. G. A., *Proc. Roy. Soc.*, A, **139**, 147 (1933).
[2] Foord, S. G., and Norrish, R. G. W., *Proc. Roy. Soc.*, A, **152**, 196 (1935).

Reflection of Medium and Short Radio Waves in the Troposphere

THE discovery that radio waves could be reflected in the troposphere was announced by us[1] and immediately corroborated by Watson Watt and his coworkers[2]. Since that time, many observations have been made upon both long and short waves and the diffraction theory of G. N. Watson[3] has been simplified for numerical calculation. The calculations show that diffraction alone will not account for the intensity of the received signal. It was then thought by some experimenters that refraction due to changing air densities might be responsible for most of the bending in the troposphere. However, Englund and his associates[4] have clearly shown that the waves (in their case less than 5 metres in length) are reflected from the boundaries of different air masses.

We have been examining the tropospheric reflections of medium and short waves (1,614–17,310 kc.) at vertical incidence for almost four years, and our observations are in complete agreement with Englund's theory for short waves. For example, whenever a cold high-pressure area comes in from the northwest, the measured height of the *C* region falls, rising again as the high is succeeded by a low-pressure area from the same direction.

In order more fully to confirm our theory that the medium and short waves could be reflected vertically from the interface between two different air masses, we have sent up an aeroplane which took readings on the air temperatures at different heights directly over the radio station, while we were measuring the heights of the reflecting layers by means of the radio pulse. Several flights have been made with the following results :

Flight	Date	Height of *C* region by radio pulse above sea-level (km.)	Height of temperature inversion by aeroplane above sea-level (km.)
1	Dec. 22, 1938	1·4	1·2
2	Dec. 28, 1938	1·09	1·04
3	Jan. 2, 1939	1·2, 1·8 } two reflections	1·15, 1·7 } two reflections
4	Jan. 5, 1939	1·52–1·9	1·5 turbulent air
5	Jan. 6, 1939	1·14–1·29, 1·50–1·63 } two reflections	1·16 discontinuity 1·56 sharp inversion
6	April 22, 1939	1·45–1·75, 2·3–2·6 } two reflections	1·4–1·65, 2·1 } turbulent air

This is the first direct comparison between the two methods. The agreement is nearly perfect. The aeroplane was furnished by Dr. L. S. Adams, president of the Tri-State Aviation Corporation.

Using two transmitting sites simultaneously, we have measured the same reflection heights over various base-lines in different directions. Frequencies between 1,614 kc./sec. and 17,310 kc./sec. failed to show any marked differences in the heights of the reflecting regions. The strength of the reflected waves decreased at the higher frequencies. During the past three years, all the stronger reflections have come from regions between 0·5 km. and 2·5 km. above our altitude of 0·29 km.

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A. W. FRIEND.

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May 15.

[1] NATURE, **137**, 782 (May 9, 1936).
[2] Watson Watt, R. A., *et al.*, NATURE, **137**, 866 (May 23, 1936).
[3] Watson, G. N., *Proc. Roy. Soc.*, A, **95**, 546 (1919).
[4] Englund, C. R., Crawford, A. B., and Mumford, W. W., *Bell Syst. Tech. J.*, **17**, 489 (October 1938).

Potentials at Oil-Water Interfaces

WHEN a water-immiscible phase, called an oil, separates two aqueous phases, there is in general a potential difference between the aqueous phases. Since this potential difference is much greater than those found when electrolytes diffuse freely in water, it has been assumed that diffusion in the oil cannot account for the observed potentials[1]. Bauer[2] at one time, and more recently Ehrensvärd and Sillén[3], suggested that these potential differences are caused by adsorption at the interfaces. Craxford, Gatty and Rothschild[4] pointed out that adsorption as such can only influence potential under two conditions, namely, if the interface is a perfect insulator or if adsorption influences the rate of diffusion of ions across the interface. Unless the interfacial monolayers have a resistance to anions or cations comparable with the bulk phases, it can be shown that they cannot affect the potential when a steady state has been attained.

I have measured the potential difference between a hanging drop and a sessile drop of water in oils lighter than water in such a way that the thickness of the oil between the interfaces could be varied. Albumin attached to a moist glass fibre can be passed through the oil and spread at either interface. When both interfaces are protected by albumin films, they can be pressed together so that only a thin 'soap bubble' of oil remains between.

There is a quick change of potential when albumin is spread at an oil-water interface, so that the water becomes negative with respect to the oil. This potential difference decays to zero at a rate that increases with increasing conductivity of the oil. With oils of specific resistance of 10^9 ohms, the half-life is about 10 minutes, at 10^8 ohms only a few seconds. Sweeping with a brass barrier in the usual way produces similar time potential curves even if the interface is originally quite clean.

At the oil-water interface, the oil molecules can be regarded as forming an oriented monolayer with their polar groups in the water. As a consequence of this sheet of oriented dipoles, charge separation across the interface will build up diffuse double layers in both phases, so that at equilibrium there will be no potential difference across the system. If the diffuse double layer is disturbed, either by changing the dipole fields or by sweeping with a barrier, time will be required to re-establish equilibrium in the two phases. Since a spreading film drags with it quite thick layers of water[5], and presumably oil, the potentials observed after spreading a protein film may be due largely to mechanical disturbance of the double layer.

The addition of electrolytes to one of the aqueous phases will produce diffusion potentials if one of the ions is more soluble in the oil. Methylene blue chloride and sodium eosinate both produce high potentials of opposite sign as if the dye ions were diffusing into the oil ahead of the Cl^- or Na^+ ions. Using butyl acetate as the oil, eosin can be seen diffusing into the oil and the potential falls in a few hours. With high resistant oils these potentials fall more slowly, and methylene blue chloride in 0·01 molar potassium sulphate against octyl alcohol maintained a negative potential of more than 70 mv. for 24 hours. Protein films at the interface have no effect on these diffusion potentials. However, if two drops protected by protein films be pressed together, reducing the oil to a thin film, the potential drops to zero, since there is insufficient resistance in the thin oil phase to maintain a concentration gradient of appreciable magnitude in the oil. With octyl alcohol it is sometimes possible to separate the drops and regain the diffusion potential. With butyl acetate the films stick together to form a stable triple layer that prevents convection but has little or no effect on diffusion or potentials and has a resistance of less than 0·5 ohm cm^2.

The above considerations throw doubt on any explanations of steady bio-electric potentials based on interfacial potentials or diffusion potentials across thin oil films. However, since some monolayers can retard the evaporation of water, it is possible that monolayers may exist that can influence oil-water potentials by virtue of their low ionic permeability.

A full account of these experiments with further theoretical treatment will be published elsewhere.

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[1] Michaelis, L., "Hydrogen Ion Concentration", 192 (1926).
[2] Bauer, *Z. phys. Chem.*, **92**, 81 (1916). See Adam, N. K., "The Physics and Chemistry of Surfaces", 361 (1938).
[3] Ehrensvärd, G., and Sillén, L. G., NATURE, **141**, 788 (1938).
[4] Craxford, S. R., Gatty, O., and Rothschild, NATURE, **14**, 1098 (1938).
[5] Schulman, J. H., and Teorell, T., *Trans. Faraday Soc.*, **34**, 1337 (1938).

Adjustment of Electrical Units

THE international body responsible for the allocation of values to electrical units, the General Conference of Weights and Measures, decided at its last meeting, in 1933, to change at some future date the long-accepted value of the ohm; no more regrettable decision could have been taken.

Recent measurements show that the ohm is 5 parts in 10,000 greater, and the ampere 1·5 parts in 10,000 less, than the values originally aimed at for them. As a result, the watt measured electrically is about 2 parts in 10,000 greater than the watt derived from the metre, kilogram and second. Physicists and electrical engineers agree almost unanimously that, for practical reasons, the electric standards ought to be adjusted so as to secure equality of the 'electrical' watt and the 'mechanical' watt.

But adjustment can be effected in several ways. The method contemplated by the General Conference of Weights and Measures is to reduce the volt by 3·5 parts in 10,000 and the ohm by 5 parts in 10,000. The change in the volt would cause no serious difficulty, but the change in the ohm entails re-engraving practically all resistance boxes, for all precision resistance boxes claim an accuracy superior to 5 parts in 100,000.

There is no doubt whatever that if an adjustment so large as 5 parts in 10,000 were made, the great standardizing laboratories, universities, scientific institutions, etc., would desire to possess standards in agreement with the new value of the ohm. The replacement of existing apparatus, much of which is all the more valuable for having been under observation for many years, would be extremely wasteful. It is also entirely unnecessary, for adjustment of the watt can be effected by keeping the ohm as it is at present, and reducing the ampere and the volt by 1 part in 10,000, as pointed out by G. Giorgi[1], G. A. Campbell[2] and others.

As the alteration of the ohm has not yet been enforced, it is to be hoped that the General Conference

will not lack courage to examine, in the light of fresh facts and new arguments, a question in which there is a considerable body of opinion opposed to its earlier decision.

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[1] Giorgi, G., "Memorandum on the M.K.S. System of Practical Units" (Central Office, International Electrotechnical Commission, London, 1934).

[2] Campbell, G. A., "A Definitive System of Units", *Bull. Nat. Research Council*, No. 93, p. 48 (1933).

Acoustic Properties of Mud Bricks

FOLLOWING up our tests of the thermal properties of mud bricks[1], we have investigated their acoustic properties by reverberation methods for sound absorption, and by direct methods for sound insulation.

The sound insulation of a 9-inch mud brick wall (uncracked) is determined by the weight per sq. foot, as is known for many other materials. Cracking commenced as drying proceeded, accompanied by a marked fall in the sound insulation.

The sound absorption of an irregular mud brick surface is very considerably greater than the same wall finished with a smooth mud surface. The measurements explain the short times of reverberation in mud brick rooms.

The results are as follows :

Sound absorption (O.W.U.)			Sound insulation in decibels.				
			Age of wall				
Frequency of sound	Irregular surface	Smooth surface	1 hr.	1 day	3 days	9 days	30 days
250	0·32	0·10	45·6	46·5	39·0	31	31
500	0·48	0·16	53·9	49·9	42·2	35	33
1000	0·56	0·19	64·4	55·3	50·5	40	40
2000	0·55	0·18	—	—	—	—	

The bricks were composed of 97·5 per cent mud and 2·5 per cent straw by weight.

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May 29.

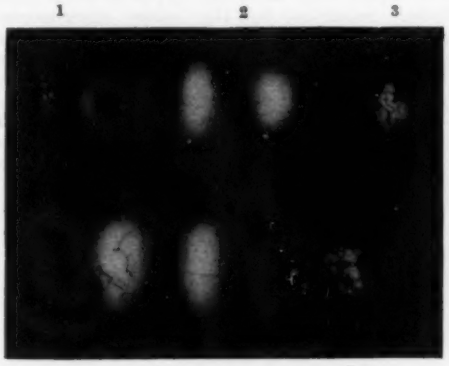
NATURE, 142, 837 (1938).

Spring Development of the Gonads of the Starling (*Sturnus v. vulgaris* L.)

IN 1937[1] and 1938[2] Rowan reported some interesting differences in the state of the gonads of the starling in winter. The gonads of birds obtained in London were considerably larger than those of birds obtained from flocks frequenting a roost in the country, and this was interpreted as indicating that the noise of traffic, by causing the birds to be restless throughout the night, had induced a precocious development of the reproductive systems. Bissonnette[3], however, failed to obtain this result experimentally.

It is known that the winter starling population of the British Isles is derived from two main sources. The results of bird marking have shown that the majority of British breeding birds remain in the country throughout the winter, whilst their numbers are greatly augmented in autumn by flocks of starlings coming from the Continental countries bordering the Baltic and the North Sea. These immigrants, which leave Britain again in March, congregate at night in roosts which contain tens of thousands of birds. It is possible, therefore, that the starlings taken by Rowan in London were British, whereas those taken in the country were Continental.

With this alternative explanation in mind, starlings were obtained between March 11 and March 21 from a quiet residential district two miles from the centre of Leeds. In this area the birds roost, for example, under the eaves of houses, where they are not subject to any disturbances from traffic during the night. No increase in their numbers can be noted during winter, and the extremely dirty condition of their feathers is additional evidence that they are town birds. These birds proved difficult to obtain, but, of the six examined, the three males were in full breeding condition. They had large white testes (see accompanying reproduction, No. 4) and their seminal vesicles contained spermatozoa. The ovaries of the females were small (No. 5), and afterwards it was found that this sex does not come into full breeding condition until the middle of April.



GONADS OF STARLINGS. NATURAL SIZE.

For comparison with these birds, which were almost certainly British, starlings were also obtained from a roost which had been established during the previous autumn in a small plantation near Beamsley Beacon in Wharfedale. Estimations, supported by photographic evidence, showed that about ten thousand birds occupied the roost each night, and it is probable that the great majority of these were of Continental origin. Between March 7 and March 14, thirty-one birds were obtained in the plantation, and, with one exception, these were sexually undeveloped. In the fifteen males, the testes (No. 1) were small and dark grey in colour, and microscopic examination showed that they were completely quiescent. The vasa deferentia and seminal vesicles were small and embedded in fat. In the females, the ovaries (No. 3) were slightly smaller than those of the town birds, and only minute eggs were present. The oviducts were very slender. These birds were therefore in a similar state to those obtained from the country by Rowan in February 1937.

One male bird, however, obtained in the roost on March 9, was entirely different. The testes (No. 2) were almost fully mature, each being large and white in appearance, and the seminal vesicles were correspondingly well developed. Although obtained in the open country, this bird was in the same condition as those in the Leeds suburb, and it therefore appeared possible that a number of local starlings were present

among the thousands of immigrants occupying the roost. This was finally proved when all the Continental birds suddenly left on March 15. A small residual population of about a thousand starlings remained to roost in the plantation each night, and, at the time of writing (May 13), they are still continuing to do so. These birds were clearly local, and they were discovered to come from a small area of some five square miles immediately adjacent to the roost. Fifteen specimens were obtained between March 22 and 25, and the seven males proved to be uniformly similar to that one male bird obtained in the roost on March 9.

Although the separation of British and Continental starlings depends on circumstantial evidence, it nevertheless appears probable that a difference exists between the times of onset of sexual activity in these two types of birds. The onset of maturation in the starling is almost certainly conditioned by the increase of daily light in the early months of the year, and it would appear that these two types of birds possess different reactions to the same environmental changes. The British birds react early and do not migrate. The Continental birds react more slowly and migrate before reaching their full sexual development.

Morphologically, the two types of starling have not been separated, but, if these results are substantiated, it is apparent that they should be treated as distinct physiological races.

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May 13.

[1] Rowan, W., "Effects of Traffic Disturbance and Night Illumination on London Starlings", NATURE, **139**, 668 (1937).
[2] Rowan, W., "London Starlings and Seasonal Reproduction in Birds", *Proc. Zool. Soc.*, A, **108**, 51 (1938).
[3] Bissonnette, T. H., "Studies on the Sexual Cycle in Birds, IV" *J. Exp. Zool.*, **58**, 281 (1931).

Formation and Breakdown of Glycogen in the Live

Parnas and Baranowski[1] have shown that glycogen undergoes a special kind of breakdown in muscle to hexosemonophosphate. The authors term this phosphorolysis of glycogen:

$$(C_6H_{10}O_5)_n + n.H_3PO_4 = n.C_6H_{11}O_6.PO_3H_2.$$

Ostern, Guthke and Terszakowec[2] identified the product formed under these conditions as a mixture of Robison and Neuberg esters.

Cori, Colorick and Cori[3] found that the intermediate step in the breakdown of glycogen to the Robison ester was the glucose-1-phosphoric ester described by them. They further showed that the glycogen phosphorylating enzyme is widely distributed and that in dialysed liver extracts it forms from glycogen glucose-1-phosphoric ester, which is partly dephosphorylated to glucose. It seems therefore possible to them ". . . that the blood sugar of mammals is produced by this enzyme system rather than by a diastase"[4].

We have used concentrated liver brei made by grinding 1 part of the liver of starved rabbits with 1 part of phosphate buffer solution at *p*H 7·2. Glycogen added to the brei is rapidly broken down as well in the presence as in the absence of fluoride. With fluoride, Cori ester is quantitatively formed, and then converted to Robison ester; provided that excess of glycogen is present, only so much is broken down as can be phosphorylated by the amount of phosphate available. Without fluoride, glucose is formed, no uptake of inorganic phosphate being detectable; this is because dephosphorylation is so rapid that the primary phosphorylation of glycogen is masked. It can, however, easily be demonstrated by the addition of *M*/200 fluoride, which completely inhibits the dephosphorylation. Under these conditions, the phosphorolysis proceeds in the liver at the same speed as in muscle; at a glycogen concentration of 2 per cent and at 37°, nearly 4 gm. of glycogen is phosphorylated by 100 gm. of liver in one hour. A velocity of breakdown of glycogen of this magnitude would be sufficient to maintain the blood sugar of an animal in face of its physiological requirements, even during exercise.

In the presence of oxygen, the phosphorylation and breakdown of glycogen are quicker than in its absence, probably because the reaction is accelerated by the oxidative removal of part of one of its products —the Robison ester.

Phlorrhizin inhibits the breakdown of glycogen in liver by more than 70 per cent. Since it specifically poisons the phosphorylation of glycogen[5], this is further proof that phosphorolysis is the chief, if not the only path of the anaerobic and aerobic glycogen metabolism in the liver.

Cori ester, added to normal liver brei, is rapidly dephosphorylated; in the presence of fluoride, most of it is converted to Robison ester, but a part of it forms a substance which gives an opalescent solution, is dextro-rotatory (α_D about +190°), gives a red-brown colour with iodine*, does not reduce, but is precipitable by alcohol, and reduces after hydrolysis. We think, therefore, that this substance is glycogen. In an experiment in which 80 mgm. of Cori ester was added to 10 gm. of liver brei poisoned by fluoride, 7·6 mgm. of glycogen was formed, corresponding to about 20 per cent of the Cori ester. The reaction is thus clearly similar to that described by Schaffner[5] and by Kiessling[6] as taking place in yeast. Since phosphorylations are involved in the formation and breakdown of glycogen in liver, it is understandable that glycogen from liver (however carefully prepared) contains some organic phosphorus[7].

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May 24.

* Cori, Schmidt and Cori reported recently (*Science*, **89**, 464; 1939) that glycogen is formed from Cori ester by purified muscle enzymes. The fact that their product gives a blue colour with iodine is very interesting, and shows perhaps that there are differences between the synthesis of glycogen in liver and in muscle.

[1] Parnas and Baranowski, *C.R., Soc. Biol.*, Paris, **121**, 282 (1936).
[2] Ostern, Guthke and Terszakowec, *Hoppe-Seyl. Z.*, **243**, 9 (1936).
[3] Cori, Colorick and Cori, *J. Biol. Chem.*, **117**, 135 (1938); **118**, 619 (1937).
[4] Cori and Cori, *Proc. Soc. Exp. Biol.*, N.Y., **39**, 337 (1938).
[5] Schaffner, *Naturwiss.*, **27**, 195 (1939).
[6] Kiessling, *Naturwiss.*, **27**, 129 (1939).
[7] Ostern and Hubl, *Acta Biol. Exp.*, **13** (in the press).

A Grass Leviathan from East Africa

DURING an expedition which the Government of the Union of South Africa sent recently to East and Central Africa for the purpose of collecting grasses which might prove of value to the Union for pasture,

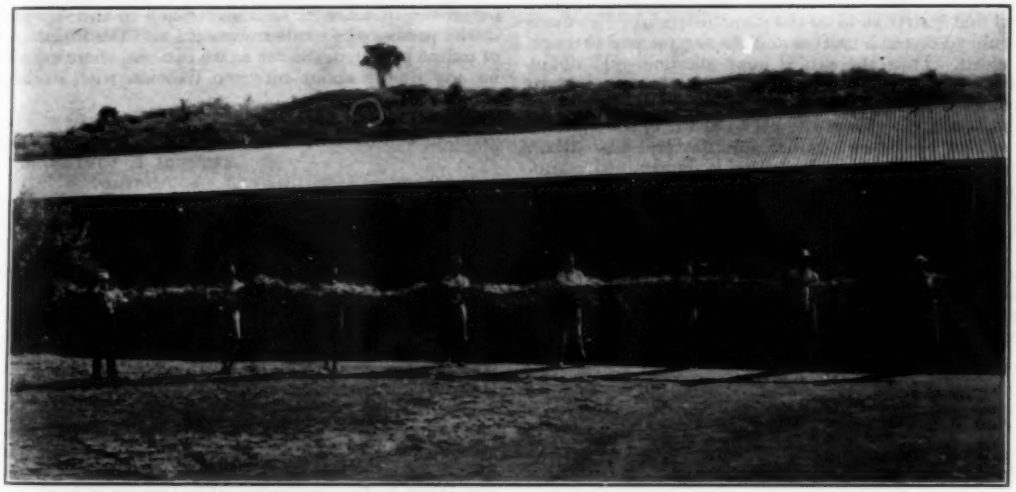
hay, silage and erosion control, a remarkable grass was encountered and collected in East Africa and has since been grown at the Department of Agriculture's Grass Introduction Research Station at Pretoria with astonishing results. The grass combines all the attributes of a pasture, hay and soil preserver in such a remarkable manner that it is felt that it deserves more than ordinary notice. The grass belongs to what is known locally in East Africa as the Star grasses. These occur commonly in the Rift Valley and are regarded amongst the farming community, both black and white, as the best and most nutritious grasses in ranching country. For example, in the country around Lake Solai, the dry bed of which is covered with these grasses, it has long been the custom of stockowners who have grazed their animals in the country around Nakuru, where they invariably suffer from 'nakuritis', to send them to the rich Star grass pastures of Lake Solai, where they immediately pick up in condition and recover.

These Star grasses belong to the genus Cynodon Rich., to which the common dog's tooth, Bermuda grass, couch grass of Australia, Bahama grass of the West Indies, the doub grass of India and the kweek-gras of South Africa also belong. There is great variation both in the habit and structure of these grasses, but they are usually placed by botanists under the name *Cynodon plectostachyum*.

A number of these Star grasses were encountered by the expedition in Tanganyika and Kenya, but on examining the grass plots laid down at Kabebe, near Nairobi, by Mr. D. C. Edwards, grassland officer to the Government of Kenya, I was shown a remarkable Star grass in one of his plots, which he stated had appeared there by accident and had evidently been introduced by seed contained in a sod of a fine-leaved lawn grass (also a Cynodon) from Uganda. Apart from this, the origin of the grass was unknown. This Star grass was standing nearly three feet high in the plot, and was regarded as a promising hay type. The edges of the plot, however, were kept closely trimmed and thus little indication of the true character of the grass was manifest. The grass was so outstanding that it was decided to keep a sharp look-out for it. The expedition first encountered this giant Star grass in its natural habitat in the evergreen and deciduous parkland country between Eldoret and Kitale in the Trans Nzoia province of Kenya, and along the eastern foothills of Mount Elgon. Afterwards it was collected frequently in Uganda in the neighbourhood of Ruwenzori, in the Semliki Valley, around Lake Edward and Lake George and in several localities in the eastern Belgian Congo.

Apart from its luscious and dense stand, often 3–4 feet in height, the most remarkable character of the plant in the veld was its amazing network of robust runners or stolons, and it was at once realized that in this plant Nature had provided us with valuable material for erosion control. Living material was brought to Pretoria and was planted out under conditions where the growth of the plants could be studied in detail. The plants have been under observation for some five and a half months and during this period, under a rainfall of 27·49 inches, they have made remarkable growth.

Individual plants during this time have covered more than eight thousand square feet of soil, and in many instances have put out runners (with offshoots) from the parent plant, measuring in length more than fifty feet. These runners and offshoots, of course, anchor themselves down firmly at almost every node. The material offers great possibilities for erosion control in areas where this grass can be successfully established.



A GIANT STAR-GRASS RUNNER (WITH OFFSHOOTS) MEASURING 48¼ FEET IN 5½ MONTHS FROM THE TIME THAT IT LEFT THE PARENT PLANT.

GROWN AT RIETONDALE PASTURE RESEARCH STATION, PRETORIA.

I. B. POLE EVANS.

Division of Plant Industry,
Department of Agriculture and Forestry,
Pretoria.
May 17.

Oxaloacetic Acid in the Leguminous Plants

INVESTIGATIONS in our laboratory have revealed that oxaloacetic acid has a central position in biological fixation of nitrogen. Recently P. W. Wilson[1] reported that, contrary to the findings in this laboratory, he has not been able to find oxaloacetic acid in the growing legumes. In the determination of oxaloacetic acid, Wilson employed the aniline manometric method of Ostern, making the determinations in the expressed sap of the plant material from which the proteins are precipitated with tungstate in a sulphuric acid solution.

Oxaloacetic acid disappears easily from the plant material during the preparation of the sap if the respiratory system is active. Therefore we have employed a different procedure in preparing the plant sap. Since oxaloacetic acid is most stable in alkaline solution—according to Straub the stability increases at least up to *p*H 14—we add caustic soda solution (1 c.c. of 10 per cent solution per 3 gm. fresh plant) and fine quartz sand to the plant material. The mass is rubbed fine in a mortar and the sap pressed through a cloth. Thus the sap is kept alkaline—*p*H about 12–13—right from the start and the respiratory system is destroyed. The sap is cooled at 0°, sulphuric acid is added to lower the *p*H to about 5, the solution is added to Ostern's buffer solution and the carbon dioxide formed through aniline is determined manometrically in the Warburg apparatus. By this method we have found, for example, in the leaves of young red clover grown in the greenhouse in April–May, 48–264 γ oxaloacetic acid per 1 gm. The accompanying table illustrates one of our determinations carried out with red clover at the start of flowering. Oxaloacetic acid was destroyed in one experiment by heating the acidified plant sap.

t° C.	Minutes	Thermobarometer	4 c.c. dil. plant sap + 2 c.c. buffer + 0·05 c.c. aniline + 0·2 c.c. water		4 c.c. dil. plant sap + 2 c.c. buffer + 0·25 c.c. water. No aniline
			Exp. acc. to the method described	Sap acidified and heated	
8·9	0	151	153	149·5	151
9·3	30	167	179	165·5	167
		16·0	26·0	16·0	16·0
Change in the pressure			10	0	0
Oxaloacetic acid (γ) per 1 c.c. sap 104				0	0

Daily and diurnal variations are considerable, as would be expected. After flowering of peas, oxaloacetic acid is no longer found.

We have modified for plant material also the method of Szent-Györgyi and Straub for the colorimetric determination of oxaloacetic acid. Two samples of equal size are taken from the plant material. Hydrazine hydrochloride is added immediately to one sample and the mass is rubbed fine in a mortar. To the other sample is added sulphuric acid to make the *p*H of the mass about 3, and the mass is kept at room temperature for 4 hours to destroy the oxaloacetic acid completely. Both samples are then extracted with ether in a percolator for 36 hours. The ether solutions are shaken frequently with soda solution. The soda solutions obtained are acidified with sulphuric acid to *p*H 2–3, cooled at 0°, whereupon sodium nitrite solution is added. After 5 minutes, the solution is made strongly alkaline with caustic potash and the yellow colour formed thereby is determined colorimetrically. The difference in the colours of the two samples should be due to the amount of oxaloacetic acid. The reliability of this method is being further investigated by us. On the basis of the determinations hitherto, the latter method seems to give higher values than the manometric method described above. If the plant material is made strongly alkaline right from the start, as described in connexion with the manometric method, the values obtained by the manometric and colorimetric methods have been in good agreement in the determinations hitherto carried out.

In the article referred to, Wilson states also that he has not been able to bring about nitrogen fixation with excised root nodules in the solution of oxaloacetic acid. This result is at great variance with the numerous experiments carried out in our laboratory. In most experiments we have determined the nitrogen fixation by Kjeldahl's method, and also in some experiments by determining the amount of nitrogen in the gas mixture[2]. In addition, we have noted the increase of amino nitrogen in the solution in the presence of oxaloacetic acid and the formation of oxime nitrogen. So far as we can see, there cannot be any doubt about nitrogen fixation with excised root nodules.

A more detailed account of our experiments will be given in the *Biochemical Journal*.

ARTTURI I. VIRTANEN.
A. A. ARHIMO.
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May 22.

[1] Wilson, *Erpob. Enzymforsch.*, **8**, 13 (1939).
[2] Apparatus described in Virtanen's paper in *Svensk Kemisk Tidskrift*, **51**, 19 (1939).

Discovery of Sugar-cane Seedlings

AN interesting review of the book "The World was my Garden", by David Fairchild, appeared in NATURE of December 31, 1938, p. 1138. In this review I note the following sentences: "There are occasional slips, as for example on p. 123, when the late Dr. J. B. Harrison is described as being the discoverer of sugar-cane seedlings. In Barbados and the West Indies generally, this honour has always been ascribed to the late John R. Bovell."

Neither the reviewer nor the author of the book is strictly correct. Seedling canes were found by the overseer of a Barbados plantation so early as 1858, and the discovery recorded in the Barbados *Liberal* of February 12, 1859, while the fertility of the cane was established at about the same time in Java, Reunion and Mauritius. Systematic research work on the production of new seedling varieties of sugar-cane dates from the re-discovery of the fertility of the cane by Soltwedel in Java in 1887. The discovery of seedling canes in Barbados by Harrison and Bovell, referred to by the reviewer, was a joint one made in 1888, and quite independently from that of Soltwedel. The six months period separating the dates of the Java and Barbados discoveries is explained by the fact that the cane produces its flowers in May–July south of the equator, and in November–January in the northern hemisphere. Bovell afterwards became renowned as the breeder of the world-famous *BH*.10(12) and several other valuable seedling cane varieties, while Harrison went to British Guiana and worked with cane seedling in that country.

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Cotton Mycorrhiza

THE mycorrhizal habit among tropical crops is becoming more generally recognized. A few years ago when I was isolating Fusarium from cotton roots, I noticed in the cortex the presence of fungal hyphæ which were clearly differentiated from Fusarium mycelium. I also observed that certain sparsely septate hyphæ with very characteristic projections were always found in close proximity to cotton roots.

I did not pay much attention to these structures at the time because I was concentrating on Fusarium. However, during my recent work on cotton mycorrhiza, I found the typical vesicular-arbuscular endophyte within the cortical tissues. Penetration takes place through the piliferous layer. The hyphæ penetrate two or three layers of cells and then pass into the intercellular spaces of the cortex and sometimes penetrate into the cells themselves. Vesicles of an inter- or intra-cellular type are developed in certain strains of cotton. They are terminal, round, oval or irregular. The arbuscule sporangiole apparatus is found within the inner cortical cells next to the endodermis.

Butler[1], in his recent paper on the occurrences and systematic position of the vesicular-arbuscular type of mycorrhizal fungi, named the endophytes *Rhizophagus* sp. According to his statement, he found the endophyte scarce in Gujerat, whereas in the Sudan cotton the roots were transformed into mycorrhiza and the extra matrical development of the fungus was very luxuriant.

In conclusion, it may be said that *Rhizophagus* sp. appears to grow in the soil around the cotton roots and also within the cortical tissues, producing vesicles in the first case and vesicles and arbuscular sporangioles in the second. The factors which influence the presence of the endophyte within the roots are now under investigation; but from the results so far obtained it seems that soil type, manuring and the age of the plant are chiefly instrumental.

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[1] Butler, E. J., *Trans. Brit. Mycol. Soc.*, **22**, Pts. III and IV, 274–301 (1939).

Points from Foregoing Letters

It is shown by P. M. S. Blackett that if the observed lifetime of a mesotron is to be related to the other fundamental constants, that the gravitational constant must be included. This can be done in a very simple way and may indicate a relation between atomic and gravitational phenomena.

R. G. W. Norrish and F. S. Dainton have studied the effect of pressure of reactants and foreign gases on the critical concentrations of nitrogen peroxide, and the induction periods of the hydrogen-oxygen reaction sensitized by nitrogen peroxide. The authors consider that the inhibiting effect of foreign gases is due in part to the deactivation of highly energized chain centres, and that at high pressures the inhibiting effect of reactants is due to the increased probability of self neutralization of centres.

Direct observations of temperature changes at various levels of the atmosphere by means of aeroplane flights, made simultaneously with radio measurements carried out directly underneath, to determine the height of the reflecting layers, are reported by R. C. Colwell and A. W. Friend. They confirm the view that medium and short waves can be reflected vertically from the interface between two air masses.

R. B. Dean states that oil-water potentials disappear when the oil is reduced to a very thin film, because the thin oil film is no longer able to maintain a diffusion gradient in itself. Potential differences set up when a protein is spread at one interface disappear in a short time owing to the formation across the interface of a neutralizing double layer in both phases.

P. Vigoureux suggests that the necessary adjustment in the value of the watt should be made by keeping the ohm as it is at present and reducing the ampere and the volt by 1 part in 10,000; this would obviate the scrapping of much valuable apparatus in many laboratories.

The sound absorption of an irregular mud brick surface is found by F. H. Constable and M. K. Mahas to be considerably greater than the same wall finished with a smooth surface, which accounts for the short time of reverberation in mud brick rooms.

A comparison of the gonads of British and Continental starlings points to a difference in the time of onset of sexual activity in these two forms. It is suggested by W. S. Bullough and R. Carrick that they may constitute separate physiological races.

P. Ostern and Eric Holmes state that the chief path of glycogen breakdown in the liver is by way of phosphorolysis to Cori ester, which is either dephosphorylated to glucose or converted to Robison ester. In fluoride poisoning, added glycogen is converted to Robison ester so long as phosphate is available for esterification. The excess of glycogen can be recovered, whereas without fluoride the whole of the glycogen disappears, owing to the circulation of phosphate, which is rapidly freed from hexose monophosphate. In the presence of fluoride, part of the added Cori ester is converted into glycogen and part into Robison ester.

A photograph of a giant Star-grass runner (*Cynodon plectostachyum*) from South Africa is submitted by I. B. Pole Evans. It grew 48½ ft. in 5½ months from the time it left the parent plant, and may prove to be a very valuable plant for erosion control.

A. I. Virtanen and A. A. Arhimo describe a method for the determination of oxaloacetic acid in plants. Considerable quantities of oxaloacetic acid are found in growing legumes at definite times of day. Daily and diurnal variations are great.

E. C. Stevenson writes that seedling canes were found by the overseer of a Barbados plantation so early as 1858 and the discovery recorded in the *Barbados Liberal* of February 12, 1859, but systematic research work on the production of new seedling varieties of sugar-cane dates from the re-discovery of the fertility of cane by Soltwedel in Java in 1887.

RESEARCH ITEMS

Rock Paintings and Engravings of the Western Sahara

THE first of a projected series of studies of the scientific results of Théodore Monod's expeditions to the Western Sahara in 1934–36 is devoted to rock-paintings, engravings and inscriptions (*Pub. du Com. d'Études Hist. et Scientifiques de l'Afrique Occidentale Française*, Sér. A, No. 7, 1938. Paris: Lib. Larose. Pp. 156 + 9 pls.). It includes an iconography, accompanied by a complete enumeration of known sites, followed by general remarks on classification and chronology, with a study of the inscriptions by Georges Marcy. The material of this western area is poor both in quantity and quality in comparison with the remarkable assemblages in southern Oran, Ajjers and Fezzan. Only Libyco-Berber graffiti are at all abundant, and that only in certain areas. The western material falls into two, or strictly speaking three, classes, as compared with the seven or eight distinguished by H. Winkler in the desert of Upper Egypt. The chronological problem accordingly is simplified. In the west is (I) a single undifferentiated neolithic. Next comes (II) a Libyco-Berber group, also homogeneous, but with local facies of unknown chronological relation. Thus the camel abundant at Tichitt-Oualata is rare at El Beyyed, while at Chinguetti it is the horse that predominates. Groups I and II can be distinguished readily. They belong to different cultures, of which I alone is prehistoric. Differences of patination are evidently a result of local conditions, and the only sure guides to classification are technique, style and content. Hence a 'bovine' period, corresponding, it may be assumed, to a sedentary agricultural neolithic stage, which at times was ichthyophagous, is followed by an equine-camel period, in which the lakes of the last humid phase gradually disappear and climatic conditions would appear to deteriorate. Even an approximate dating cannot be suggested, as there is no fixed point for the close of the neolithic and the arrival of the Libyan horsemen, while the only *terminus ad quem* is the Islamization of the country.

Respiratory Metabolism of Infant Brain

H. E. Himwich, Z. Baker and J. E. Fazekas (*Amer. J. Physiol.*, 125, 601; 1939) studied the respiratory metabolism of the brain of infant rats (1–24 days old) with the following results. (1) Like the adult brain, the infant brain is dependent on added carbohydrate (glucose) for maximum respiration and possesses a small aerobic glycolysis. The respiration of the infant brain is also stimulated by lactate, succinate, pyruvate and fructose. (2) On the basis of *dry* weight, during the first eleven neonatal days the rate of glucose oxidation is lower than that of lactate. In the absence of substrate and the presence of lactic acid the respiration is the same as that in the adult. (3) The oxygen consumption of the brain of the newborn rat is smaller than that of the adult brain per unit of *wet* weight of tissue. (4) The diminished capacity for oxidation may be correlated with the protein concentration, which is lower in the infant brain. The authors therefore suggest that the diminished oxidation is a quantitative rather than a qualitative phenomenon.

Human-Birth Weights

H. P. DONALD (*Proc. Roy. Soc. Edin.*, 59, 91–108; 1939) has analysed the factors influencing the birth-weight of 3,000 infants at the Else Inglis Memorial Hospital, Edinburgh. The average weight tends to be higher in the summer than in winter. Sex, order of birth, age of mother, and family characteristics are shown to influence the birth-weight. The view is favoured that birth-weight is more a quality of the mother than of the children.

Inheritance of Cataract

A RECESSIVE gene in the rat causes the degeneration of the retina of the eye about seventeen days after birth. M. C. Bourne and H. Grüneberg (*J. Hered.*, 30, 131–136; 1939) have examined histologically animals homozygous for this recessive gene. They find that in all cases the rod nuclei die and lesions appear. Secondary effects may or may not be present, such as persistence of the hyaloid artery and degrees of opacity of the lens (cataract). The characteristics resemble retinitis pigmentosa, an inherited anomaly in man. This case is interesting in showing one constant effect of a gene combined with several inconstant characteristics.

Heterochromatic Regions of Chromosomes

IN many recent cytological publications there has been an increasing tendency to recognize deeper affinity for stains in certain regions of the chromosomes. These regions more retentive of stains are described as heterochromatic. Dontcho Kostoff (*Proc. Ind. Acad. Sci.*, 8, Sect. B; 1938) has collated various aspects of this question; he points out that the regions near the centromeres tend to be heterochromatic and may persist in interphase as prochromosomes, whilst the end regions may also be heterochromatic, and sex chromosomes are often markedly so. After platinum chloride fixation and gentian violet staining, Kostoff concludes from his preparations that the chromomeres are more closely spaced in the heterochromatic regions, and this leads to his support of Koltzoff's suggestion that genes are possibly located between the chromomeres. The paper also puts together an interesting series of phenomena, such as the effects of infection by micro-organisms, glandular secretions and X-ray effects, and discusses their possible influence on chromosome conjugation and 'somatic' crossing-over. The paper has evidently lost much in its expression in the English language, but the ideas suggested, with the bibliography, are well worth consideration.

Lepidoptera of the Mascarene Islands

A CATALOGUE of these insects from the above-mentioned islands, by J. Vinson, has lately (December 1938) been published by the Mauritius Institute and Public Museum (*Mauritius Inst. Bull.*, 1, Part 4). By the expression 'Mascarene Islands' the author includes the islands of Réunion (Bourbon), Mauritius and Rodriguez. This definition is now very generally used in entomological writings. The catalogue enumerates 387 species and, of these, 43 per cent

or 168 species are endemic but only 14, or 6 per cent, of the genera are actually endemic. On the whole, the fauna of Lepidoptera is considerably richer in the Mascarenes than in the Seychelles. While there are certain cosmopolitan elements in the fauna such as the butterfly *Vanessa cardui* and such moths as *Heliothis armigera*, *Ephestia cautella*, *Pyralis farinalis* and *Plutella maculipennis*, there are others of more special interest. Thus *Papilio phorbantia* is confined to Réunion and *P. manlius* is only found in Mauritius. There are also Danaid butterflies of the genus Euploea, namely, *E. goudotii*, *euphon* and *desjardinsi*. They are confined to Réunion, Mauritius and Rodriguez respectively. Among the moths, the sub-family Hypeninæ provides many peculiar and restricted species. For example, of the twelve species of Hypena, seven are endemic in Mauritius or in Réunion. The small moth *Crambus seychellus*, which is unknown outside the Seychelles, is represented in Mauritius and Réunion by a distinct race, namely, *emmerezellus*. Its larva is a serious pest of lawns in Mauritius where it has become known locally as the lawn cut-worm. Mention needs also to be made of the family Metachandidæ the species of which are almost all confined to the Mascarenes and Seychelles, with a few species in India.

Life in Arctic Ice and Snow

A report recently issued by the Smithsonian Institution gives an account of E. Kol's studies of plants growing in ice and snow in the Mount McKinley National Park, Alaska. Reference is made particularly to three organisms, and the remarkable feature which emerges is the prolific growth that occurs during the short season when the surface of the ice or snow melts temporarily in the August sun. The surface of the Columbia Glacier is described as covered for miles by light brownish-purple algal vegetation known as ice-bloom; the organism responsible is the green alga Ancylonema, which Dr. Kol has also found in various localities in Europe, but never in sufficient quantity to form ice-bloom. Above Valdez, around the Thompson Pass, the snowfields at the beginning of August showed the phenomenon of red snow, the coloration extending from the surface to a depth of several inches, and in one case to two feet, into the snow. The effect is produced by *Chlamydomonas nivalis*. The red snow in this particular pass looked as if sprinkled with red pepper, instead of the raspberry red of some other snowfields. In snowfields of the mountain above Juneau, masses of tiny snow fleas were present, piled to a depth of about half an inch and giving the surface a deep violet-grey colour.

Vegetation of the Aka Hills, Assam

N. L. Bor has recently published a synecological study of this area (*Ind. For. Rec.*, New Ser., Botany, 1, No. 4, Govt. of India Press, New Delhi, Nov. 1938). Hitherto, the area from a botanical point of view was practically unexplored, for nothing but a meagre collection, by Griffith, in the foothills was known of its flora. The area was of importance phytogeographically because it lies midway in the four hundred miles wide gap between Sikkim and the Arbor Hills, areas, especially the former, well known botanically. A preliminary survey of the area is given, the biotic factors are outlined, and the various vegetational units are grouped into climax and seral communities. The special relations existing between vegetation and water in quantity are discussed in a chapter headed "Hydroseral Communities". Some important chapters are devoted to economic factors. Dr. Bor was able to collect some 3,500 species in all, though he does not pretend to have been able to visit the whole area. As an indication of the interest of the paper, the discovery of *Quercus incana*, Roxb. within this tract bridges the enormous gap which has hitherto existed between its known habitats in the north-west Himalaya and Upper Burma; whilst *Juglans regia*, L., and *Populus ciliata*, Wall, so common in the north-west Himalaya, are now found to extend well into the eastern Himalaya. A last example of a 'find' is *Salvia japonica*, Thbg. var. *parviflora*, not previously recorded outside its Chinese home.

Fungal Lodging of Wheat

The 'lodging' of wheat and other cereals has been ascribed to various causes such as excess nitrogen or wet weather, but Mary D. Glynne of Rothamsted Experimental Station has shown (*Agric. Progress*, **16**, Pt. 1, 1939) that the fungus *Cercosporella herpotrichoides* is frequently responsible for the weakening of straw at harvest time. The organism attacks young wheat plants in late autumn or early spring, and produces dark-coloured lesions upon the leaf-sheaths and leaves. It spreads through the summer, until the lumen of the straw is often filled with light grey mycelium. There is much evidence that nitrogenous fertilizers and wet conditions increase the incidence of the disease, so that control by the avoidance of these conditions is still valid. The widespread distribution of mycological lodging makes it possible, however, to adopt further measures, such as long rotations to starve the fungus, and the wide separation of wheat and barley within the rotation.

Micro-Manipulative Studies of Virus-infected Plants

Miss F. M. L. Sheffield, of the Rothamsted Experimental Station, has adopted a fascinating technique for the investigation of virus-infected cells of *Solanum nodiflorum*, *Hyoscymus niger* and other plants (*Proc. Roy. Soc.*, B, **126**, 529–538, February 1939). Micro-manipulative puncture of the cell, by the methods of Péterfi, followed by a suitable test, has shown that the relative acidity of both virus-infected and healthy cells of *S. nodiflorum* and *H. niger* is approximately the same, namely, *p*H 6·8. Non-crystalline intracellular inclusions of aucuba mosaic disease in tomato disintegrate immediately with slight mechanical pressure, or on pricking. The inclusion breaks down in 0·07*M*. concentrations of sodium, potassium or calcium chlorides, but can be removed in 0·1*M*. solutions of these salts. Infection experiments with such removed material have demonstrated that the inclusions contain virus. Striate material of tobacco mosaic and enation mosaic cannot be isolated, as it breaks down into needle-like fibres when touched.

An Electromechanical Transducer

The electromechanical transducer in the new Benioff seismograph is the subject of a paper by James J. Delvin, S.J. (*Bull. Seis. Soc. Amer.*, **28**, No. 4, Oct. 1938). The original transducer was possessed of hysteresis difficulties and itself rendered the motion of the seismograph unbalanced. E. C. Bullard also questioned the validity of the shunt in the magnetic circuit and suggested a balanced transducer. The new trans-

ducer, it is suggested by the author, overcomes all these difficulties. A diagram of the pole pieces, armature piece and air gaps is given, and this is followed by a mathematical analysis of the working. It is found that the E.M.F. output, E, is governed by the equation

$$E = k\frac{\varphi_m}{x_o}\frac{dx}{dt},$$

where k is the number of turns in the coil, φ_m is the flux through the permanent magnet, x_o is the length of the air gap in the central position of the transducer, and dx/dt is the rate of change of the air gap. In the new instrument the variations in flux are more nearly linear, the symmetry of the design renders unnecessary any calculations for the lack of symmetry such as the added stiffness of the spring in the vertical component, and there is now no such thing as an unbalanced horizontal component.

Seismological Data from the Far East

VALUABLE data of seismology are contained in publications of the Government of India Meteorological Department, and the Royal Observatory, Hong Kong. The former, contained in the *Seismological Bulletin* for April–June 1938, contains interpretations of seismograms for the Observatories of Agra, Bombay, Calcutta, Colombo, Dehra Dun, Hyderabad and Kodaikanal, together with non-instrumental reports. At Agra, 20 shocks were registered in April, 32 in May and 11 in June, commensurate numbers being registered at the other observatories. In the *Hong Kong Bulletin* of March 1939, detailed interpretations are given for 26 shocks registered there, together with all instrumental constants. This brings the total of shocks registered at Hong Kong during 1939, up to the end of March, to 74.

Crystal Structure of Glycine

ALTHOUGH there have been detailed studies of many proteins, less attention has been given to the simpler amino acids which are the basis of the more complicated structures. The crystal structure of glycine has been the subject of three investigations, which are in poor agreement. G. Albrecht and R. B. Corey (*J. Amer. Chem. Soc.*, **61**, 1087; 1939) have now made an X-ray examination of the structure of glycine in which the Patterson-Harker analysis has been used. A full account of the parameters is given and the results indicate that the structure consists of nearly flat glycine molecules held together by hydrogen bonds between adjacent nitrogen and oxygen atoms to form continuous layers throughout the crystal. Interatomic distances in the molecule are: carbon-oxygen 1·25 and 1·27 A., carbon-carbon 1·52 A., carbon-nitrogen 1·39 A., each with a probable error of ±0·02 A. Hydrogen bond distances between nitrogen and oxygen in the same layer are 2·76 and 2·88 A., and between neighbouring layers 2·93 and 3·05 A. A discussion of the probable distances of hydrogen atoms leads to the conclusion that the atomic arrangement is a *zwitter*-ion structure for the glycine molecule in the crystal.

The Electron-Microscope and the Investigation of Viruses

THREE important articles on the use of the electron microscope have recently appeared in *Die Naturwissenschaften* (**27**, 281–299; 1939). The first, by von Borries and E. Ruska, deals with the nature of the image obtained by the use of the electron ultramicroscope, in which the object is traversed by a beam of electrons. The second article, by H. Ruska, deals with the technique of work with the instrument, and particularly with the preparation of the object to be observed. The various types of carrier for the object, corresponding to the glass slide in ordinary microscopy, are considered. The carrier must be perfectly transparent to a beam of electrons, and must be uniform in thickness, and free from irregularities which would be visible under the electron microscope. A collodion film is satisfactory, and the methods of preparing the specimen on the film for observation are dealt with. A process for increasing the sharpness of an image lacking in contrast is also described. The most interesting of the three articles is the final one, by Kausche, Pfankuch, and H. Ruska, which gives the results of the investigation of plant viruses with the electron ultramicroscope. Recent progress made in the determination of the size and shape of the tobacco mosaic virus molecule is reviewed. By drying the virus solution on the carrier film, a dry gel with a definite structure is obtained. By using a sufficiently diluted solution (10^{-5} gm. of virus protein per c.c.) the lateral aggregation of the particles to bands can be prevented, so that the rods and threads can be dried out isolated from each other. The dimensions of the particles can be obtained. They vary in length, but are usually multiples of 300 mμ long, though some are multiples of 150 mμ. The diameter is about 15 mμ, or multiples of this. It is considered that the virus molecule is 300 or 150 mμ long, by 15 mμ in diameter, other dimensions being due to aggregation. Infection is brought about by one particle. If the particles are broken down by chemical means, they cease to be active.

Determination of Stellar Diameters by Interferometer

Reinhold Fürth, Kurt Sitte, and Hans Peter Appel (*Mon. Not. Roy. Astro. Soc.*, **99**, 3; January 1939) have described a modification of the Michelson interferometer method for the determination of stellar diameters. The Michelson interferometer method for finding stellar diameters is not applicable unless the air perturbations are very small. In most cases these are so great that the image of the star in the telescope moves quickly and it is impossible to see its interference fringes. If a diffraction grating is used to produce fringes and the grating is translated in its plane, the fringes do not move, and this principle has been used in the apparatus described in the paper. A secondary image of the primary interference image is produced by a suitable optical arrangement, and when the primary image is moving because of the air perturbations, the secondary image remains at rest. When the primary Michelson system of fringes disappears at a suitable distance of the slits, no secondary interferences are formed. In addition, when the contrast of the primary interferences has its maximum, the secondary will show at its optimal visibility. For these reasons the secondary interferences can be used instead of the primary to determine stellar diameters. Photographs of secondary fringes in still and disturbed air, produced by an artificial star with a diameter 0·32 mm., show that air perturbations have practically no effect upon the clearness of the interferences figures. The laboratory experiments show that stellar diameters can be measured even when there are strong air perturbations, and it is claimed that an accuracy of 10–15 per cent can be attained.

THE IMPERIAL CANCER RESEARCH FUND

THE Imperial Cancer Research Fund, the new laboratories of which were opened on June 27, was founded in 1902 to provide laboratories for cancer research and generally to provide means for systematic investigation into the causes, prevention and treatment of cancer. At that time cancer research in the modern sense had scarcely begun. The investigations of the Fund were planned from the beginning on a broad basis of statistical, comparative and experimental inquiry.

[*Photo by S. W. Newbery*

LABORATORIES OF THE IMPERIAL CANCER RESEARCH FUND.

The early "Reports" contain articles of outstanding importance on the statistical study of cancer, the ethnological distribution of cancer and the distribution and characteristics of spontaneous cancer in many species of vertebrates. The "Draft Scheme of Inquiry" drawn up by the first director, Dr. E. F. Bashford, in 1902, evidences remarkable foresight. He wrote, for example, that "the possible experimental production of 'Petroleum cancer' and 'sweeps' cancer' would have to be borne in mind and experiments carried out on a very wide series of differing species of animals. . . . A systematic study of the effects of persistent irritation of different epithelial surfaces in different species of animals might be found to have important bearings". In the event, many years elapsed before the experimental production of tumours was accomplished. The immediate task was the investigation of transplantable tumours.

Within ten years, the foundation upon which the modern experimental investigation of cancer exists, was built. The ground was cleared of many misconceptions and superstitions which impeded progress by the demonstrations that cancer occurred in primitive races, that it developed in response to external irritation resulting from occupation or personal habits, and that it was prevalent in many species of animals, the malignant cells possessing, everywhere, the same fundamental properties.

The members of the scientific staff of the Imperial Cancer Research Fund were pioneers of cancer research in Great Britain; they stood, moreover, in the forefront of investigators throughout the world. Their work was done in two rooms of the old Examination Hall of the Conjoint Board of the Royal College of Physicians and Surgeons on the Victoria Embankment until, in 1912, the laboratories were transferred to two floors of the present Examination Hall in Queen Square. The World War of 1914–18 depleted the staff and brought the investigations almost to a standstill. At the end of the War, Dr. J. A. Murray, who had succeeded Dr. Bashford as director, had the task of building up a scientific staff to carry out researches on new lines. Important contributions were made to the analysis of experimental carcinogenesis, of the metabolism of tumours by the methods introduced by Warburg and of the filterable tumours of fowls.

A small farm laboratory was built at Mill Hill in 1924, primarily for work with fowls. This arrangement involved division of the scientific staff and reduplication of laboratory equipment and services in two laboratories, neither of which provided satisfactory conditions for the increasing activities of the Fund. It was decided to abandon the laboratory in Central London and concentrate the work in a new laboratory at Mill Hill. The new building was planned under the supervision of Dr. W. E. Gye, who succeeded Dr. Murray as director in 1935, and was completed in 1938.

Many new centres for cancer research have been established, and the British Empire Cancer Campaign now administers large funds for the support of varied investigations in many institutes. The Imperial Cancer Research Fund has maintained its independence of financial and scientific control in the belief that by so doing it can continue to play an essential and unique part in cancer research. Its policy is to maintain independence but avoid aloofness. The Fund has supplied material for research probably to every institute in Great Britain and to most countries of Europe. Its help and advice are widely sought and freely given. The new laboratories will allow the extension of the practice, followed since the inception of the Fund, of granting hospitality to approved workers from all parts of the world. The choice of site was greatly influenced by the decision of the Medical Research Council to build a new National Institute for Medical Research on adjacent land. This Institute, now in course of erection, will accommodate one of the largest bodies of medical

scientific investigators in the world; the opportunities, which have been assured, for frequent and close association with the staff of the National Institute will be of great value to the relatively small and highly specialized staff of the Imperial Cancer Research Fund. This association and the distinguished executive committee, which now includes representatives of the Royal Colleges of Physicians and Surgeons, the Royal Society and the universities of Great Britain give welcome evidence of the will to guard against aloofness from the main stream of medical science.

Cancer research now extends over so vast a field that a balanced view is scarcely to be attained save by many years of intense application by workers enjoying security of tenure and opportunities for discussion with colleagues of varied outlooks. The continuity of direction and thought in the laboratories of the Fund ensures that the hardly won lessons of the past shall not be forgotten; the tradition of accurate experimentation, sober judgment and intellectual freedom is of no less importance for the future. The Fund is peculiarly fitted by reason of its permanent and independent organization, to follow the path of patient and far-sighted investigation into the fundamental problems of cancer; a path which though beset with hardships and, too often, passing through dark places, must inevitably reach the goal. The new laboratories provide the opportunity for the prosecution of these investigations with increased vigour and efficiency.

SIXTH CENTENARY OF THE UNIVERSITY OF GRENOBLE

ON May 14, the city of Grenoble celebrated the sixth centenary of the foundation of its University. The ceremonies, at which were present representatives of all the French universities, and of a large number of other universities, European and American, lasted three days, and took place partly at Grenoble, partly at the historic castle of Vizille, the cradle of the French Revolution, where one could invoke the shades of Mounier, Barnave and Lafayette, and partly in the regional centres associated with the University, namely, Valence, Vienne, Chambéry and Annecy. Ten distinguished foreigners, of whom three were British, three Belgian, and one each from the United States of America, Denmark, Sweden and Yugo-Slavia, were made doctors *honoris causa* of the University of Grenoble.

This token of interest, coming from all parts of the world, in a small provincial French university, is understandable only if one knows the history of the development of the University of Grenoble. It was on May 12, 1339, that Humbert II, the last independent Dauphin, a somewhat ostentatious prince who was almost a megalomaniac, and who, to pay his debts some years later, ceded Dauphiné to France, obtained from Pope Benoit XII a Bull authorizing the foundation at Grenoble, a market town of scarcely 4,000 inhabitants, of a permanent *studium generale* for canonical and civil law, medicine and the arts.

The new university was transferred shortly afterwards to Valence, and only in 1808 did it return definitely to Grenoble. Among the dozen professors comprising the University then were Champollion, the celebrated Egyptologist, and his brother Champollion-Figeac, both of whom were natives of the region. In spite of the reputation of some of its graduates, it remained for a long time one of the smallest universities of France. The Faculty of Sciences, in particular, provided for its four professors only a single laboratory, which was described by Raoult, who began there his celebrated experiments on cryoscopy, in the following words:

"Les professeurs n'y possédaient chacun en propre qu'une petite table; encore ce laboratoire, pendant le jour, servait-il en même temps d'habitation à la concierge. Le professeur de physique y arrangeait ses instruments; celui de zoologie y disséquait ses lapins et y nourrissait des pigeons; le professeur de géologie y cassait des cailloux et y débourbait des fossiles, et le professeur de chimie y faisait toutes ses opérations. Les deux préparateurs et l'unique garçon, sans doute pour eviter l'encombrement, n'y faisaient, malgré les reglements de service, que des apparitions discrètes; mais par contre, la vieille concierge de la Faculté, depuis le matin jusqu'au soir et à la meilleure place, cousait des sacs, faisait sa cuisine et donnait audience à ses amies."

The University, so poor and so lacking in endowment, took a sudden and rapid step forward when the water-power of the neighbouring mountains transformed Grenoble and its outskirts into a highly industrialized centre. The Faculty of Sciences met the new developments by the creation of the Polytechnic Institute and its annexes, the schools of paper-making and of hydraulic engineering, then those of the Institute of Electrochemistry and Electrometallurgy, of the Institute of Zoology and Pisciculture with a station at Vizille, of the Institute of Botany with a branch at the Col de Lautaret, of the Institute of Geology and Alpine Geography, of the Institute of Chemistry and finally of the Fourier Institute for physics and mathematics. Many of these centres have acquired a reputation far beyond the boundaries of France and receive each year an imposing body of foreign students. The Faculties of Law and of Letters did not lag behind in this forward movement; the first established a commercial institute and the second institutes in Florence, Naples and Rome. At the same time, it organized courses for foreigners attracted by a region of great natural beauty and by a very well organized "Comité de Patronage des Etudiants étrangers".

At the present time, the University of Grenoble is one of the largest in France from the point of view of number of students. Since 1900, it has received more than 40,000 foreign students of all nationalities, including among others Prince Konoye and Herr von Ribbentrop, foreign secretary of the German Reich, who was there when M. Daladier, now premier of France, was professor of history at the Lycée of Grenoble.

P. VAILLANT.

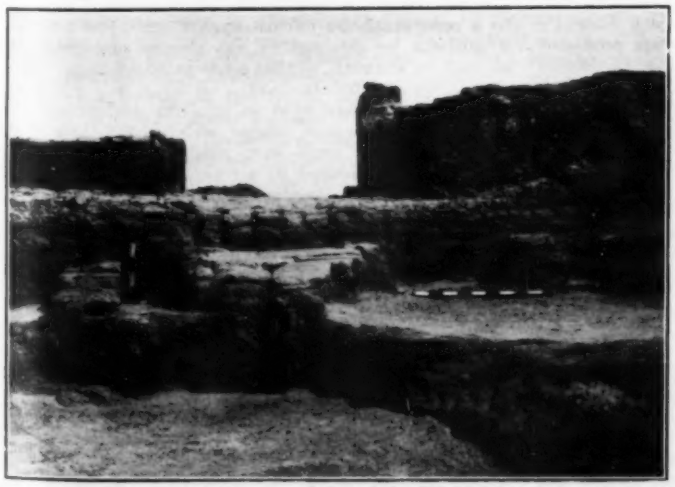
EXCAVATIONS AT AMARAH WEST, SUDAN, 1938-39

AN exhibition of antiquities, the results of an excavation carried out at Amarah West in the Sudan on behalf of the Egypt Exploration Society, was opened in the Department of Archæology and Egyptology of University College, in the University of London (Gower Street, London, W.C.1), on June 20, and will remain open until July 15 daily from 11 a.m. to 5.30 p.m.

The ancient fortified site of Amarah West in the Northern Province of the Sudan is situated between the second and third cataracts of the Nile, about 120 miles south of Wadi Halfa. It is on the left bank of the river, and consists of a small walled town overlooking the river, and cemeteries and other ancient remains in a wide circle round the town. The town crowns a small mound, and is so deeply buried by sand and other debris that before excavation no walls were visible. Originally a brick enclosure between 100 and 150 yards square, in which lie the temple and its magazines and other storerooms and dwellings, the town had spread outside the protection of its walls. A short distance to the north lies the New Kingdom Egyptian cemetery, and beyond this is a wide area covered by ancient remains, most of which appear to belong to a Sudanese culture of which little, if anything, appears to be known at present. Although the town now lies on the left bank of the river, excavation has shown that very probably it once lay on an island, the main channel running between the left bank and the town itself, giving it an admirable position for the control of river traffic. Some traces of the original landing stage have been discovered.

AMARAH WEST: REMAINS OF AN ANCIENT TREE, ONE OF A SERIES, WHICH FLANKED THE ENTRANCE TO THE TEMPLE

The main work of the first season's excavation has been the examination and recording of the temple, which lies in the north-east corner of the enclosure, and consists of a forecourt, peristyle, hypostyle hall, and sanctuary area. The forecourt is built outside the north wall of the town, and in it, flanking the entrance, are pits in which were found the stumps of ancient trees still standing three feet high, two columns, and parts of two large stelæ built into niches, and bearing duplicates of well-known texts, in which Rameses II records his marriage with the daughter of the King of the Hittites and a dream in which the god Ptah appeared to him. In the Hypostyle Hall the twelve columns still stand some 9–10 ft. high, and here some of the most valuable discoveries of the season were made. Among these are the large hieroglyphic stelæ, which form a feature of the exhibits now at University College, while the walls were inscribed with scenes of a religious nature and with incidents from the Syrian wars of Rameses II, including an interesting view of a Syrian town, of which the walls are being undermined by Egyptian sappers. The most important discovery, however, and one which will prove ultimately of the greatest interest, both geographically and historically, is a long list of more than two hundred names of Syrian



AMARAH WEST: EAST SIDE GATE WITH FORECOURT SHOWING FLOOR LEVELS OF DIFFERENT PERIODS.

and Sudanese towns and peoples who owed allegiance to Rameses II. This list occupies the lowest register of all the walls of the Hypostyle Hall, and is the longest discovered in recent years. More than half the Syrian names have not occurred previously in hieroglyphic, and new identifications have been made, including what is probably the name Jericho, now appearing for the first time in an Egyptian text.

Beyond the Hypostyle is a small vestibule remarkable for the fine quality of many of its reliefs; and finally is the Sanctuary with side chambers and stone stairs leading to the roof.

The excavations have shown that the temple in its present form was built by Rameses II, but it was not completed until the sixth year of Rameses IX, some 140 years later. In its original state the temple consisted of the area covered by the Hypostyle and the present Sanctuary, which could not have existed then in the present form, as the entrance was on the south. Later, the Peristyle was added and acted as the Sanctuary. Later still, the entrance on the south was blocked up, a new gate was cut through the north wall of the town, and the original Sanctuary at the north end was pulled down and was rebuilt as the present Peristyle, while the forecourt was built outside the town to protect the new entrance. Occupation of the town goes back to at least the reign of Sethos I, father of Rameses II, and it is possible that the earliest occupation of the site dates so far back as the reign of Hatshepsut and Tuthmosis III in the Eighteenth Dynasty.

Owing to the exceptional height to which the walls now stand, a height rare on an Egyptian site, the town will probably prove the most complete and best preserved town of Pharaonic Egypt yet discovered. On the historical side, inscriptions of no less than ten kings have been found with details of wars, the names of new viceroys of Ethiopia, new material concerning known viceroys, and the important new lists of Syrian and Sudanese towns. On the archæological side, the most important discoveries are the remains of a hitherto unknown Sudanese culture, and in addition sherds of the recently discovered 'Saharan' civilization. Hitherto 'Saharan' sherds have been found only in Egypt near Armant and in the Sahara as far east as Selima Oasis. It has been presumed that the Saharan people came from the desert and made their way to Egypt from the south; but the precise point of entry into the Nile Valley was unknown. The discovery of sherds of this civilization at Amarah, which lies at one end of the shortest caravan route to Selima, would appear to indicate that the first place in the Nile Valley to be reached by this people has now been discovered. It may have been one of their important centres, a resting place after the desert journey. Future excavation may be expected to bring to light new facts bearing upon the history and character of the culture. The exhibits, thought to belong to the previously unknown 'Sudanese' culture, consist of a number of agate, flint and chalcedony arrow-heads together with some basalt axe-heads.

The excavations have been under the direction of Mr. H. W. Fairman. It is expected that complete excavation of the site will take at least four to five seasons.

ANGULAR DISTRIBUTION OF SUBMARINE DAYLIGHT

THE angular distribution of the illumination under water, and its variation with depth and surface light conditions, is of interest for several reasons. In the first place, a comparison of the actual distribution not very far below the surface with that which we would expect to find below a perfectly smooth water surface, with the given daylight conditions, would enable us to estimate the amount of scattering caused by the surface, and so to check Clarke's suggestion that the considerable extinction produced by a wind-ruffled surface is chiefly due to the formation of bubbles the chief action of which would be to scatter some of the light and increase its average obliquity. Secondly, by comparing the distributions at different depths, we could judge the relative importance of absorption and of scattering in the extinction of the illumination, since absorption by the water, by matter in solution, or by dark and opaque matter in suspension, would cause enhanced extinction of the oblique rays and render the average light more nearly vertical, while scattering by particles would render it more diffuse. Thirdly, from a knowledge of the polar distribution and of the vertical illumination as measured by a photometer with a horizontal window, we could calculate the total illumination, which is the determining factor in photosynthesis. The latter could be measured directly with a spherical photometer if such could conveniently be employed.

Important advances in our knowledge in this direction have recently been made by Pettersson and his co-workers, and the latest paper on the subject by Johnson and Liljequist* describes numerous experiments in Swedish waters with two types of photometer; in the first, an opaque disk mounted axially at a variable distance above a wide-angle photometer enables all light above any desired altitude to be screened off, and the effect of each altitude zone to be obtained by difference. In the second, the sensitivity of the photometer is limited to a comparatively narrow-angled cone, the axis of which can be directed in any desired direction in altitude or azimuth, so that a complete polar distribution curve can be obtained.

The results show that in sunlight and comparatively smooth water, under which conditions the majority of the tests were made, the under-water light is chiefly limited to a cone of rays the axis of which is near the theoretical direction of the direct sunlight. With increasing depth, the axis of the cone becomes more nearly vertical, and its angle increases, the first effect being due to absorption and the second to scattering. The former, however, seems to be much the more important agent in the extinction. The authors also give figures for the ratio total/vertical illumination. This naturally falls as the light becomes more nearly vertical, either due to increasing solar altitude or to increase of depth of immersion. The authors' figures range from 1·23 to 1·51. H. H. P.

* Svenska Hydrografisk-Biologiska Kommissionen. Skrifter, Ny serie. Hydrografi 14: On the Angular Distribution of Submarine Daylight and on the Total Submarine Illumination. By Nils G. Johnson and Gösta Liljequist. Pp. 16. (Göteborg: Svenska Hydrografisk-Biologiska Kommissionen, 1938.)

AMERICAN SPECIES OF CREPIS

E. B. BABCOCK and G. L. Stebbins, jun., have published in a Carnegie Institute of Washington Publication in 1938 a comprehensive survey of the American species of Crepis. About a hundred pages are devoted to the descriptions of species, including keys to species, sub-species and apomictic forms within the species. The types described fall within twelve groups derived from twelve endemic diploid species in each of which $x = 11$, and which are probably all derived by hybridization and polyploidy from Old World species with 4 and 7 pairs of chromosomes. It is suggested that the former arose in eastern Siberia in the warmer middle and late Tertiary times.

The diploid species occur in circumscribed areas, being limited mainly by climatic, though in part by edaphic factors. The *Crepis runcinata* group differs from the other species groups by being entirely diploid and sexually reproduced; evolution within this species has apparently been by mutation and other agencies, followed by selection in response to climatic and edaphic influences; the extreme types show intergrading and are interfertile, so that all are included within the *Rassenkreis* of the single species. The other species show evolution mainly by polyploidy. The 'gigas' autopolyploids show similar distribution to the parent diploid, whilst allopolyploids, with characters intermediate between the parent species, are also more tolerant of climatic and edaphic factors than either parent and consequently tend to have a wider range. With hybridization there is a strong tendency for the sterile intermediate forms to be maintained by apomixis; such apomictic forms are often sufficiently definite to warrant separate descriptions and keys for identification. The discussion of the behaviour of the species showing polyploidy and apomixis includes comparison with other genera known to behave in a similar manner.

The whole survey is very complete, and it is of great interest to have the distribution of the species mapped and discussed in relation to the climatic changes since the probable time of origin of the species. The wider distribution of the polyploid types indicates the greater tolerance of these to factors, which have presumably exterminated the diploids except from localized centres. This history of the Crepis flora and the preference of particular species for certain climatic and edaphic conditions may enable this genus to serve as a guide in further studies of the development of the present day flora.

The use made of structural features in estimation of polyploidy is worth mention. In many cases the average length of the guard cells of stomata from fully developed basal leaves gives a good guide as to the degree of polyploidy, though care has naturally to be exercised where hybridization has involved species with different initial size of guard cells in the diploid species. It was also found that pollen grains from diploid forms are approximately uniform in size and have three germ pores, whilst those of tetraploids are also uniform, some being predominantly three-pored, some four-pored. Triploid and pentaploid forms have markedly irregular pollen, with at least some four-pored grains. Thus differentiation between adjacent chromosome numbers, 22 from 33 or 44 from 55, may be drawn from examination of pollen, whilst distinctions between 22 and 44 or 33 and 55 chromosome types is obvious from the size of the stomata.

MODERN METALLURGICAL RESEARCH

ON June 22, Prof. F. Wever, of the Kaiser Wilhelm Institute für Eisenforschung in Düsseldorf, delivered a lecture at the Royal Society on "The Development and Present State of Modern Metallurgical Research". The lecture was one of those arranged under the scheme for an exchange of visits between representatives of the Royal Society and the Kaiser Wilhelm Gesellschaft, but it was clearly impossible in the space of a single lecture to deal with such a wide field as the title indicates, and actually Prof. Wever confined his attention to certain aspects of research on the structure and constitution of alloys and the transformations that influence them.

In a brief review of the early development of the basic methods of metallographic investigation, he paid tribute to the German, French and British men of science who were the pioneers in microscopy, thermal analysis and the construction of constitutional diagrams. In this part of the lecture his theme was that microscopic examination reveals the arrangement of the crystals in solid metals, thermal analysis enables the changes which affect this to be studied, while the application of the laws of heterogeneous equilibrium to co-ordination of the data obtained by these methods results in the construction of diagrams which represent the relations between constitution on one hand and composition and temperature on the other.

After a brief reference to the more recently developed study of metals by means of X-ray analyses, which enables the arrangement of the atoms in the crystals to be ascertained, Prof. Wever went on to deal with modern investigations on the kinetics of the transformations in solid metals. This is a field of research with which he has been closely associated, and most of this part of the lecture was concerned with the work of his colleagues and himself. As investigations of this kind have been confined to the study of the transformations that occur in steel during cooling at different rates, attention was confined to the effect of the rate of cooling on the temperature of the changes, the progress of these changes at different constant

temperatures below the critical range, and the structures produced in steels of different carbon content cooled at different rates or allowed to transform at different constant sub-critical temperatures.

Since the investigations of Dejean in 1917 and Portevin in 1919, it has been known that a progressive increase in the rate of cooling results in the first place in a gradual lowering of the normal changes, and in the second place, when a certain critical rate is exceeded, in the discontinuous depression of the changes to a lower temperature at which martensite is formed. Researches carried out since 1930 in the Kaiser Wilhelm Institute have contributed to present knowledge about the various changes and the relations between them. It has been shown, for example, that once the rate of cooling is sufficiently rapid to prevent any changes taking place above the martensite point, further increase in the rate of cooling does not produce further lowering of the martensite change. Thus a line may be drawn in the iron-carbon diagram to indicate the temperature at which the martensite change begins in steels of different carbon content, or a three-dimensional diagram may be drawn to show the relations between carbon content, rate of cooling and the temperatures of the transformations. It has also been known for some time that when steel is cooled to about 500° C. at a rate that suppresses the normal change, and is then cooled more slowly or maintained at constant temperature, an intermediate transformation occurs. The investigations with which Prof. Wever has been associated indicate, however, that this intermediate transformation may also proceed to some extent during continuous cooling at certain rates. Thus by cooling steels at progressively increasing rates, three kinds of changes may be obtained, namely, the normal, the intermediate and the martensitic.

By means of a magnetic balance, the progress of the normal and the intermediate changes at different constant temperatures has been studied. This work has shown that the rate of the normal austenite-pearlite transformation increases to a maximum as the temperature at which it is caused to take place is lowered, but further lowering leads to a diminution in the rate and it finally becomes extremely slow. A characteristic of this change is that at all temperatures there is a period of delay before it begins. At temperatures below that at which the normal change can take place the intermediate change occurs. This begins immediately, proceeds at a rate that becomes more rapid as the temperature is lowered, and continues to an extent that increases as the temperature is lowered. At still lower temperatures the martensite change takes place with great rapidity, and investigations on iron-carbon-nickel and iron-carbon-manganese alloys have shown that the martensite change in carbon steels corresponds to the $\gamma \rightarrow \alpha$ change in iron-nickel or iron-manganese alloys.

FISSION OF URANIUM NUCLEI

PROF. OTTO HAHN of the Kaiser Wilhelm Institut für Chemie, Berlin-Dahlem, was guest lecturer, on the invitation of the Royal Society, at the Royal Institution on Friday, June 23. Prof. Hahn's subject was "The Fission of Uranium Nuclei by Neutrons", and his account was chiefly historical. As the first definitely to establish the production of elements of medium atomic weight (fission products) when uranium is bombarded by neutrons, Prof. Hahn naturally confined himself mainly to describing the chemical method of investigation used by his colleagues and himself.

He described in detail how, in the process of confirming and extending the earlier investigations of Fermi and Curie and Savitch, Dr. Strassmann and he were forced to conclude that short-lived isotopes of barium and lanthanum were produced from uranium. These bodies could be separated from radium and actinium isotopes, but not at all from inactive barium or lanthanum, respectively, either by fractionation or by chemical means. Meitner and Frisch discussed these results in terms of division of the heavy nucleus into roughly equal fragments and Frisch showed, for the first time by a physical experiment, that the predicted large amount of energy is released in the act of fission. Thereafter, said Prof. Hahn, the whole subject was widely studied in a great many laboratories throughout the world. In his own laboratory, the chemical investigation was continued and the production of xenon, as fission product together with strontium, was established. The active barium and lanthanum, on this showing, arise chiefly as decay products following xenon and cæsium isotopes.

Up to this point, Prof. Hahn had described only previously unknown activities, but he went on to show how first one and then another of the so-called trans-uranic elements, postulated to explain most of the early work on the uranium disintegration, were proved, by purely chemical means, also to belong to the middle, rather than the end, of the periodic table. This was established by physical methods in other laboratories; but his own experiments had carried the matter further in one particular respect. After a great deal of labour, he had been able to show that the eka-iridium of the earlier classification contained molybdenum as well as tellurium—even though the half-value periods of the two active isotopes were distressingly similar! There remained only the task of applying the same methods of exact chemistry to the other activities which had not so far been studied, Prof. Hahn said, for his own contribution to the problem to be complete.

In the discussion which followed this most interesting lecture, Prof. Niels Bohr gave an account of the theoretical treatment of the fission problem recently undertaken by Dr. J. A. Wheeler and himself in the United States, and further contributions were made by Prof. M. L. E. Oliphant, Dr. E. Bretscher, Prof. G. P. Thomson and others.

Dr. Bretscher mentioned the results of preliminary experiments using large quantities of lead tetra-ethyl, which appear to show that fission occurs (though with a very small cross-section) with lead under fast neutron bombardment.

N. F.

UNIVERSITY EVENTS

BELFAST.—Dr. R. H. Sloane has been appointed lecturer in experimental physics and Mr. G. Williams has been appointed lecturer in zoology.

W. R. Crawford has been approved for the degree of D.Sc. in mechanical engineering.

CAMBRIDGE.—Prof. D. M. S. Watson, Jodrell professor of zoology and comparative anatomy, University of London, has been appointed to give the Herbert Spencer Lecture in Trinity term, 1940.

EDINBURGH.—Mr. James Brough, of the University of Manchester, has been appointed lecturer in the zoology of vertebrates in succession to Dr. C. H. O'Donoghue, and Mr. J. E. G. Raymont, of University College, Exeter, has been appointed lecturer in the zoology of invertebrates in succession to Dr. Peter Gray.

GLASGOW.—At Commemoration Day on June 21, the honorary degree of doctor of laws was conferred on the following, among others: Sir Andrew Duncan, chairman of the executive committee of the British Iron and Steel Federation; Prof. W. J. Goudie, emeritus professor of the theory and practice of heat engines, University of Glasgow; Prof. I. M. Heilbron, professor of organic chemistry, University of London; J. McFadyen McNeill, naval architect, Glasgow; Prof. F. J. M. Stratton, professor of astrophysics, University of Cambridge; Prof. G. G. Turner, professor of surgery, University of London.

LEEDS.—Dr. M. G. Evans has been elected to the chair of physical chemistry, in succession to the late Prof. H. M. Dawson (see p. 15).

Dr. R. G. S. Hudson has been elected to the chair of geology which will become vacant on the retirement of Prof. A. Gilligan at the end of the present session (see p. 16).

Dr. J. B. Speakman has been elected to the chair of textile industries in succession to the late Prof. A. T. King (see p. 15).

The following appointments have also been made: Mr. Frederick Whalley, as lecturer in anæsthetics; Mr. Herbert Agar, as tutor in obstetrics and gynæcology; Mr. A. Stewart Johnstone, as lecturer in radiology; Mr. R. V. Riley, as research assistant in the Fuel Department.

LONDON.—Prof. Frank Horton, University professor of physics at Royal Holloway College, has been elected vice-chancellor for the year 1939–40.

Mr. Harry Stobie has been appointed, as from October 1, to the University chair of dental surgery and pathology tenable at the Royal Dental Hospital of London School of Dental Surgery. From 1932 until 1936 he was postgraduate instructor in oral surgery at the Royal Dental Hospital and since 1930 he has held the part-time posts of honorary dental surgeon, dean and director of teaching, and lecturer in dental surgery and pathology at that hospital.

Dr. Harold Heywood has been appointed, as from October 1, to the University readership in mechanical engineering tenable at the Imperial College of Science and Technology. From 1936 until 1938 he was lecturer in mechanical engineering at the City and Guilds College and since March 1938 he has been senior research officer at the British Coal Utilisation Research Association.

SCIENCE NEWS A CENTURY AGO

Equipment of Magnetic Observatories

THE study of terrestrial magnetism, which had made great strides in the early part of last century through the work of Hansteen, Gauss, Humboldt, Sabine and others was advanced another stage by the dispatch in 1839 of an expedition to the Antarctic under the command of Capt. James Clark Ross, for whom the Admiralty had fitted out the *Erebus* and *Terror*. The *Athenæum* on July 6, 1839, referring to this said: "We long since announced that a naval expedition was about to proceed to the Antarctic Seas, for the purposes of magnetic research and observation. In consequence the Royal Society have resolved to address a letter to such foreign societies as were most likely to take an interest in the subject, calling on them to aid, as far as possible, in executing a concerted system of observation". The *Athenæum* then printed the letter of the Royal Society which said that "Her Majesty's Government has ordered the equipment (now in progress) of a naval expedition of discovery, consisting of two ships, under the command of Capt. James C. Ross, to proceed to the Antarctic Seas for the purposes of magnetic research and also the establishment of fixed magnetic observatories at St. Helena, Montreal, the Cape of Good Hope, and Van Dieman's Land having for their object the execution of a series of corresponding magnetic observations during a period of three years. . . . The Court of Directors of the Honourable East India Company have also in compliance with the suggestion of the Royal Society, resolved to establish similar observations at Madras, Bombay, and at a station in the Himalaya Mountains. . . ." The communication was accompanied by a report made to the Council of the Royal Society by a joint committee of physics and meteorology. It was intended that a series of meteorological observations subordinate to, and in connexion and co-extensive with, the magnetic observations should be made.

Ross's expedition was a very successful one, and he penetrated to within less than twelve degrees of the South Pole. The Royal Geographical Society awarded him a gold medal in 1841 and after his return home in 1843 he was knighted.

Prevention of Steam-boat Accidents

IN consequence of the numerous accidents to steam vessels a century ago, the Government appointed Captain Pringle and Josiah Parkes to report on the causes and the prevention of such accidents. The first part of their report was printed in the *Mechanics' Magazine* of July 6, 1839. They recommended that a Board should be set up under the Board of Trade to register and classify all steam vessels, that surveyors should be appointed to inspect and report on the condition of vessels, that the Board should investigate all accidents, that an annual report should be made to Parliament on the state and progress of the mercantile steam marine, that instructions should be drawn up for the surveyors, that an abstract of the law relating to steam-boats should be placed in a conspicuous place in each vessel, that hulls should be surveyed half-yearly, that licences should be issued, and that the surveyor should ascertain that the safety valves in the boilers were the right size, and that no licence should be granted to vessels having the spindles or levers of the safety valves on deck.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

ADVISER IN AGRICULTURAL BOTANY (MYCOLOGIST) in the University of Manchester—The Registrar (July 1).

LECTURER (WOMAN) IN NATURE STUDY AND EDUCATION in the City of Leeds Training College—The Director of Education, Education Department, Calverley Street, Leeds, 1 (July 3).

SUPERINTENDENT OF BALLISTIC RESEARCH in the Research Department, Royal Arsenal, Woolwich—The Under-Secretary of State (C.5), The War Office, London, S.W.1 (July 7. Quote appts. /150 A).

SUPERINTENDENT FOR A WAR DEPARTMENT EXPERIMENTAL ESTABLISHMENT—The Under-Secretary of State (C.5), The War Office, London, S.W.1 (July 7. Quote Appts./151 A).

LECTURER IN MECHANICAL ENGINEERING in the Heanor Mining and Technical School—The Director of Education, County Education Office, Derby (July 8).

ASSISTANT BOTANIST at the Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1 (July 10).

ADVISER ON PLASTICS in the Directorate of Scientific Research of the War Office (and later for the Ministry of Supply when formed)—The Under-Secretary of State (C.5), The War Office, London, S.W.1 (July 10. Quote Appts./153).

ASSISTANT LECTURER IN ZOOLOGY in the University of Manchester—The Registrar (July 12).

ASSISTANT LECTURER IN GEOLOGY in the University of Leeds—The Registrar (July 12).

PROFESSOR OF CHEMISTRY in the University of Aberdeen—The Secretary (September 16).

PROFESSOR OF ENGINEERING in Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 88A, Gower Street, London, W.C.1.

CURATOR OF THE PITT-RIVERS MUSEUM in the University of Oxford—The Registrar.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Labour. Report for the Year 1938. (Cmd. 6016.) Pp. iv+136. (London: H.M. Stationery Office.) 2*s*. net. [26

City and County of Bristol: Bristol Museum and Art Gallery. Report of the Committee for the Year ended 31st December, 1938. Pp. 28+4 plates. (Bristol: Museum and Art Gallery.) [56

Proceedings of the Royal Society of Edinburgh, Session 1938–1939. Vol. 59, Part 2 (No. 14): Studies on Reproduction in the Albino Mouse. 2: Contributions on the Maturation of the Sperm Cells. By Hugo Merton. Pp. 145–152. (Edinburgh: Robert Grant and Son. Ltd.; London: Williams and Norgate, Ltd.) 9*d*. [56

Report by the Hydrographer of the Navy on the Surveys carried out by H.M. Naval Surveying Service, and on the Work of the Hydrographic Department for the Year 1938. Pp. 10. (London: Admiralty.) [56

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich. Pp. 45. (London: Royal Observatory.) [56

The Birds of Staffordshire. Issued as Appendices 1-9 to the Transactions and Annual Report of the North Staffordshire Field Club, Vol. 64, 1930, to Vol. 72, 1938. Pp. 288. (Stoke-on-Trent: North Staffordshire Field Club.) [56

University of Oxford: Committee for Advanced Studies. Abstracts of Dissertations for the Degree of Doctor of Philosophy. Vol. 11 (Dissertations accepted during 1938.) Pp. v+306. (London: Oxford University Press.) 3*s*. net. [66

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 788, Vol. 238: Investigations on Magne-Crystallic Action, 6: Further Studies on Paramagnetic Crystals. By K. S. Krishnan, A. Mookherji and A. Bose. Pp. 125–148. 3*s*. Series B: Biological Sciences. No. 563, Vol. 229: The Origin and Developmental Mechanics of the Avian Sternum. By Honor B. Fell. Pp. 407–463+plates 33–41. (London: Cambridge University Press.) [76

Royal Meteorological Society. Bibliography of Meteorological Literature. Vol. 4, No. 6 (July–December, 1938.) Prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office. Pp. 294–351. (London: Royal Meteorological Society.) 2*s*. 6*d*. [76

Proceedings of the Royal Irish Academy. Vol. 45, Section B, No. 7: River Liffey Survey—2: The Food Consumed by the Brown Trout (*Salmo trutta* Linn.) in Acid and Alkaline Waters. By Winifred E. Frost. Pp. 139–206+plate 24. 3*s*. Vol. 45, Section B, No. 8: On the Occurrence of *Gammarus duebeni* (Lilli.) (Crustacea, Amphipoda) in Ireland. By D. M. Reid. Pp. 207–214. Vol. 45, Section B, No. 9: Notes on the Ecology of the Sandy Beaches of North Donegal. By Colin B. Rees. Pp. 215–230. 1*s*. Vol. 45, Section B, No. 10: A Further Contribution to the Flora of Ireland. By R. Lloyd Praeger. Pp. 231–254. 1*s*. Vol. 45, Section B, No. 11: Some Observations on the Glaciation of North-East Ireland. By J. Kaye Charlesworth. Pp. 255–296+plates 25–27. 4*s*. Vol. 45, Section B, No. 12: Bathymetric Survey of Three Lakes in Co. Wicklow. By H. J. Seymour. Pp. 297–300+plates 28–30. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [76

The Carnegie United Kingdom Trust. Twenty-fifth Annual Report, January–December, 1938. Approved by the Trustees at their General Meeting held on Friday, 3rd March, 1939. Pp. vi+86. (Dunfermline: Carnegie United Kingdom Trust.) [76

The Colonial Empire. Statement relating to the period 1st April, 1938, to 31st March, 1939, to accompany the Estimates for Colonial and Middle Eastern Services, 1939. Presented by the Secretary of State for the Colonies to Parliament by Command of His Majesty, May 1939. Pp. iv+98. (London: H.M. Stationery Office.) 1*s*. net. [86

Report of the British Guiana Refugee Commission to the Advisory Committee on Political Refugees, appointed by the President of the United States of America. Presented by the Secretary of State for the Colonies to Parliament, by Command of His Majesty, May, 1939. (Cmd. 6014.) Pp. 20. (London: H.M. Stationery Office.) 4*d*. net. [126

New Tendencies in Colonial Policy. With an Introduction by Leonard Barnes. Pp. 16. (London: Pacifist Research Bureau.) 2*d*. [126

War and the Colonies: a Policy for Socialists and Pacifists. Pp. 16. (London: Pacifist Research Bureau.) 2*d*. [126

International Tin Research and Development Council. Publication No. 94: Report for 1938. Pp. 22. (Greenford: International Tin Research and Development Council.) [126

The Royal Society for the Protection of Birds. Forty-eighth Annual Report, January 1st to December 31st, 1938, with Proceedings of Annual Meeting, 1939. Pp. 114. (London: Royal Society for the Protection of Birds.) 1*s*. [126

Ministry of Health. Report of the Inter-Departmental Committee on Abortion. Pp. vi+168. (London: H.M. Stationery Office.) 2*s*. 6*d*. net. [126

Other Countries

Export Trade In and Byproducts Uses of Tobacco: Letter from the Secretary of Agriculture transmitting in response to Senate Resolution No. 291 (75th Session) a Report pertaining to the Export Trade in and Byproducts Uses of Tobacco. (Senate: Document No. 39.) Pp. viii+56. (Washington, D.C.: Government Printing Office.) [26

Forest Research Institute. Woodworking Series, No. 2: Laminated Wood. By W. Nagle. Pp. viii+7+7 plates. (Dehra Dun: Forest Research Institute.) [56

Cornell University: Agricultural Experimental Station. Bulletin 709: Marketing Fruits and Vegetables on Farmers' Markets, New York Metropolitan District. By M. P. Rasmussen. Pp. 60. Bulletin 710: The Peach Enterprise in Western New York; Soil Relationships, Costs and Returns, and Marketing. By Herrell F. DeGraff. Pp. 57. Bulletin 711: Soils in Relation to Fruit Growing in New York, Part 14: Tree Behavior on Important Soil Profiles in the Finger Lakes Area. By Damon Boynton. Pp. 21. Bulletin 712: State Reforestation in Two New York Counties; The Story of the Land and the People. By T. E. LaMont. Pp. 23. Bulletin 713: The Composition of Rural Households. By W. A. Anderson. Pp. 24. Bulletin 714: Problems in the Production of Iceberg Lettuce in New York. By J. E. Knott, E. M. Anderson and R. D. Sweet. Pp. 17. Memoir 218: The Effect of Temperature on the Photoperiodic Response of Spinach. By J. E. Knott. Pp. 38. Memoir 219: Neutralization Curves for the Humic Acids of Peat Soils. By B. D. Wilson and E. V. Staker. Pp. 19. (Ithaca, N.Y.: Cornell University.) [56

28 Bericht der Naturforschenden Gesellschaft. Die ältesten Räderuhren und modernen Sonnenuhren: Forschungen über den Ursprung der modernen Wissenschaft. Von Ernst Zinner. Pp. 148+50 plates. (Bamberg: Naturforschenden Gesellschaft.) [56

Fiskeridirektoratets skrifter, Serie Havundersøkelser. Vol. 6, No. 1: Fisken og Havet. Pp. 104. Vol. 6, No. 2: Torsken i Oslofjorden. Av Johan T. Ruud. (Bergen: A.s John Griegs Boktrykkeri.) [56

League of Nations: Child Welfare Information Centre. Annual Report on Child Welfare for the Third Session of the Advisory Committee on Social Questions. Pp. 202. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 4*s*. [56

Colony and Protectorate of Kenya. Report on a Visit to Kenya. By Dr. J. B. Pole-Evans. Pp. 36+18 plates. (Nairobi: Government Printer.) 2*s*. 6*d*. [126

U.S. Department of Agriculture. Technical Bulletin No. 643: Food Habits of North American Diving Ducks. By Clarence Cottam. Pp. 140+10 plates. (Washington, D.C.: Government Printing Office.) 30 cents. [126

Catalogues, etc.

The Nivoc Supplement. No. 6, Industrial Series, April. Pp. 12. (London and Birmingham: W. and J. George, Ltd.)

'Ceramite' Resistance Units. Pp. 12. (London: Zenith Electric Co., Ltd.)

Radiography and Clinical Photography. Vol. 3, No. 1. Pp. 16. (London: Kodak, Ltd.)

Photographs from Exposure to Print. Pp. 24. (London: Burroughs Wellcome and Co.)

Catalog and Price List of Eastman Organic Chemicals. Thirtieth edition. Pp. 124. (Rochester, N.Y.: Eastman Kodak Company.)

A Catalogue of Books on Botany, Agriculture, Forestry, Fruit-Culture, Gardens and Gardening, Tobacco. (No. 563.) Pp. 100. (London: Bernard Quarich, Ltd.)

Old Books: a Collection of Early Photographs and Books commemorating the Centenary of Fox Talbot and Daguerre, 1839–1939. (Catalogue 52.) Pp. 80+12 plates. (London: E. P. Goldschmidt and Co., Ltd.)

Reagent Bottles with Sandblast or Enamelled Labels. (Pamphlet No. 354.) Pp. 4. Dust Estimation: Measurement of Particle Size. (Publication No. 356.) Pp. 2. (London: A. Gallenkamp and Co., Ltd.)